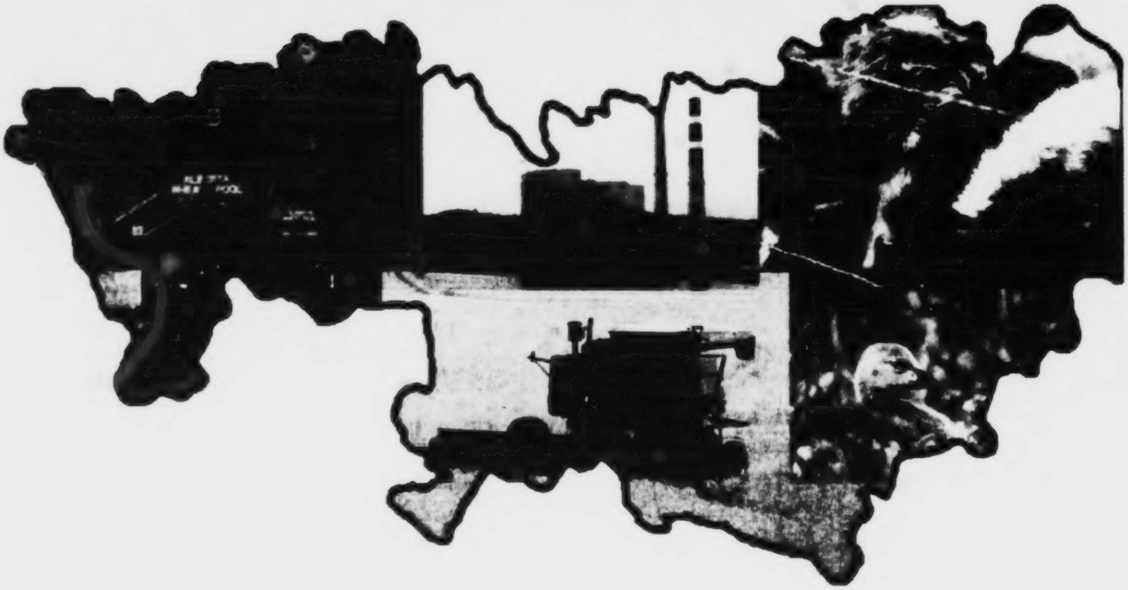
BATTLE RIVER BASIN:



WATER USE ASSESSMENT AND PROJECTIONS

Submitted to
Alberta Environment
Red Deer, Alberta

Submitted by
Watrecon Consulting
Edmonton, Alberta

August 31, 2005

EXECUTIVE SUMMARY

Purpose

Alberta Environment commissioned this study as part of Phase One of the Battle River Watershed Management Planning Process. The purpose of the study was to determine licenced water allocations and actual use of water in the Battle River Basin (BRB) and to forecast future water use in the basin.

Scope and Methodology

The BRB covers 25,500 square kilometres in east-central Alberta. Surface water supplies are derived entirely from local surface run-off (rain and snowmelt) and groundwater. For this analysis the BRB was broken down into three sub-basins based on socio-economic data. To describe current demographic and economic characteristics and trends, data from the 2001 Census were used. Forecasts were prepared for 2015 and 2030, which represent 10- and 25-year planning horizons. Both surface water and groundwater use were examined.

Water licence information was provided by Alberta Environment in November 2004. Municipal water use was determined based on a review of annual reports submitted to Alberta Environment, plus contact with some individual communities. Irrigation water use was estimated based on discussions with Alberta Agriculture, Food and Rural Development and Ducks Unlimited. Industrial water use was determined in consultation with ATCO Electric while the Albert Energy and Utilities Board provided statistics on use of water for oilfield injection. Ducks Unlimited provided estimates of water use for wildlife management.

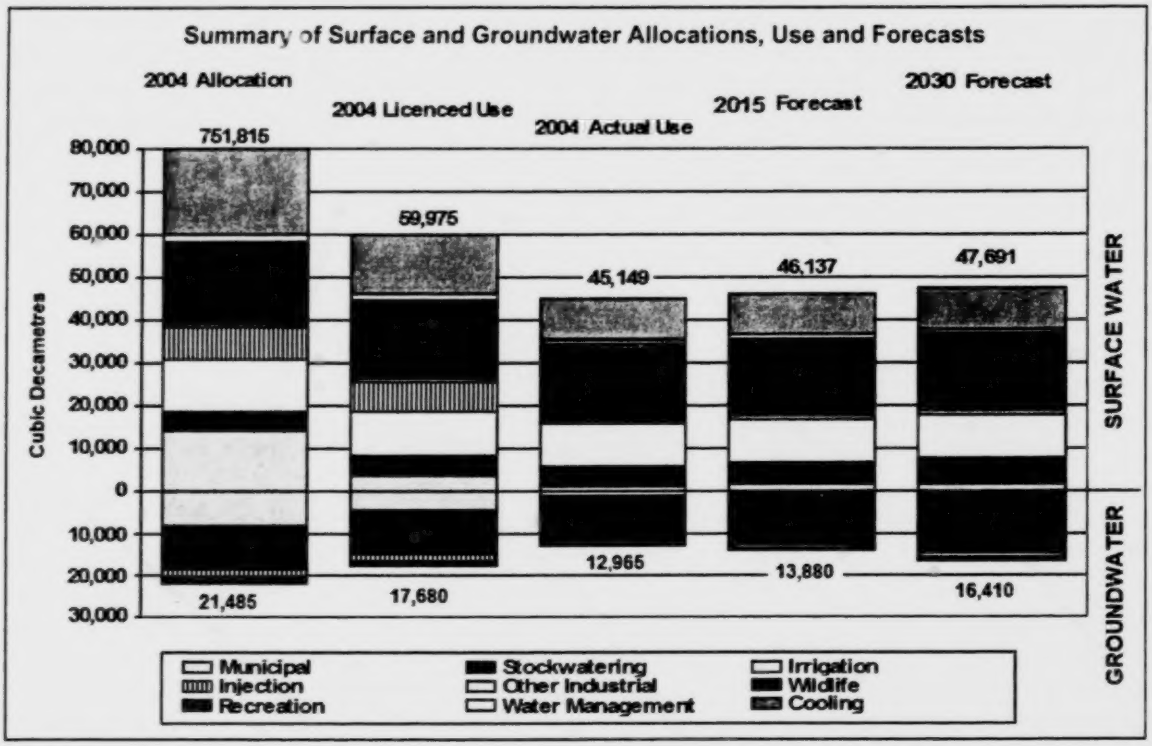
The assessment of water use differentiates between licenced water use, which represents the maximum amounts that licensees are entitled to use, and actual water use, which is based on current levels of water use. The assessment also differentiates between water withdrawals, which represent the amount of water taken from surface or groundwater sources, and water use, which includes consumption and losses and represents water that is not available for reuse. The difference between water withdrawals and water use consists of return flows, which are available for reuse.

Summary of Results

As of November 2004, licences and registrations issued in the BRB allowed 751,814 cubic decametres (dam^3 or 1000 cubic metres) of surface water and 20,844 dam^3 of groundwater to be withdrawn for use. The allocation of surface water is misleading, however, because three surface water licences issued to ATCO Electric for its thermal power plant accounted for 691,737 dam^3 (92 per cent of the total) but only 13,741 dam^3 of licenced water use.

A better descriptor of current water allocations is the maximum amount of water that can be consumed or lost (water use). Licence information shows that a maximum of 77,650 dam^3 of water can be used in the BRB. This consists of 59,975 dam^3 of surface water (77 per cent) and 17,680 dam^3 of groundwater (23 per cent). Of the maximum, 21 per cent can be used for wildlife management, 19 per cent for stockwatering, 18 per cent for thermal power, 14 per cent for irrigation, 12 per cent for oilfield injection, 11 per cent for municipal, and the remaining five

percent for other industrial purposes, recreation, and water management projects. The following figure shows the licenced allocations and licenced use in 2004 for all major water uses, for both surface and groundwater.



Actual water use in 2004 was determined to be 75 per cent of the maximum allowed by surface water licences and 73 per cent of groundwater allocations. Overall, about 58,114 dam^3 was lost or consumed. Within the BRB, wildlife management accounted for 29 per cent of actual water use, followed by stockwatering at 26 per cent. Water used for irrigation and cooling (thermal power) each accounted for 17 per cent of actual use. Municipalities only accounted for 4.3 per cent of water use, but this does not include use of water imported from other basins (235 dam^3) or rural households that use water without a licence (1233 dam^3). While oilfield injection accounts for a significant portion of water allocations, only a small percentage of these licences are actually being used, such that this use accounts for 0.6 per cent of total use.

Forecasts of future water use were developed for each of the major water use sectors. Municipal demands are based on population forecasts that reflect regional economic and demographic differences. The population of the upper basin is expected to continue to grow rapidly (1.0 per cent per year) while the middle basin will decline (-0.4 per cent per year) and the lower basin will increase moderately (0.5 per cent per year). A significant change will occur in 2005 when Lacombe and Ponoka will switch to imported surface water from the City of Red Deer, thereby significantly reducing demands on groundwater in the basin.

Livestock populations are predicted to increase at rates similar to those seen prior to the discovery of BSE in Alberta. Livestock populations and water use are assumed to increase at

about 1.2 per cent per year with lower growth rates in the upper basin and higher in the middle and lower basins. Irrigation water use is predicted to remain unchanged over time because of the high cost of irrigation equipment, the relatively low returns from irrigated forage, and the limited availability of surface water .

Use of water for cooling (thermal power) is assumed to remain constant over time as ATCO continues to operate at approximately 70 per cent of its maximum operating capacity and no expansions are planned. The amount of water used for oilfield injection will continue to decline as the oilfields in the basin age and production declines. Other industrial water use is predicted to increase as a result of economic diversification in the BRB. This increase is expected to be about 30 dam^3 per year.

Water used for other purposes is predicted to increase slightly over the forecast period. While the amounts used for wildlife management and water management are assumed to remain constant, there will be small increases in recreation water use likely due to increased golf course development in the BRB.

The net result of these forecasts is that water use in the BRB is predicted to increase to 60,000 dam^3 by 2015 and 64,100 dam^3 by 2030. This represents an increase of about 190 dam^3 per year to 2015 and 270 dam^3 per year until 2030. Most of these increases will result from expansion of the livestock industry. Over time, more demand will be placed on groundwater resources, with the result that by 2030 groundwater will account for 27 per cent of water use, compared to 23 per cent at present.

The overall pattern of water use is expected to change very little over time. Stockwatering will increase to 31 per cent of total use by 2030, while the proportions used for wildlife management, irrigation and thermal power production will decline slightly. The amount of total water used by municipalities and for other purposes will continue to be very small and, proportionately, will remain constant over the forecast period.

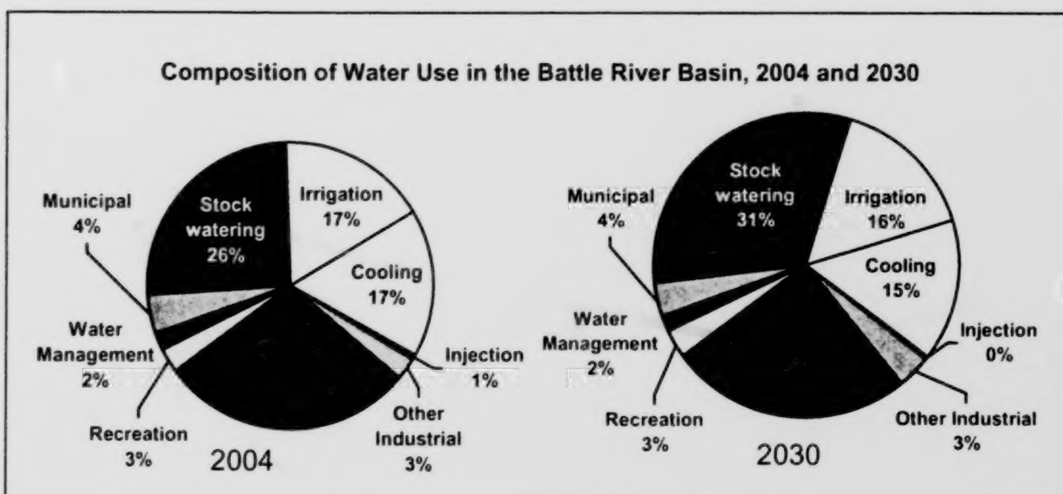


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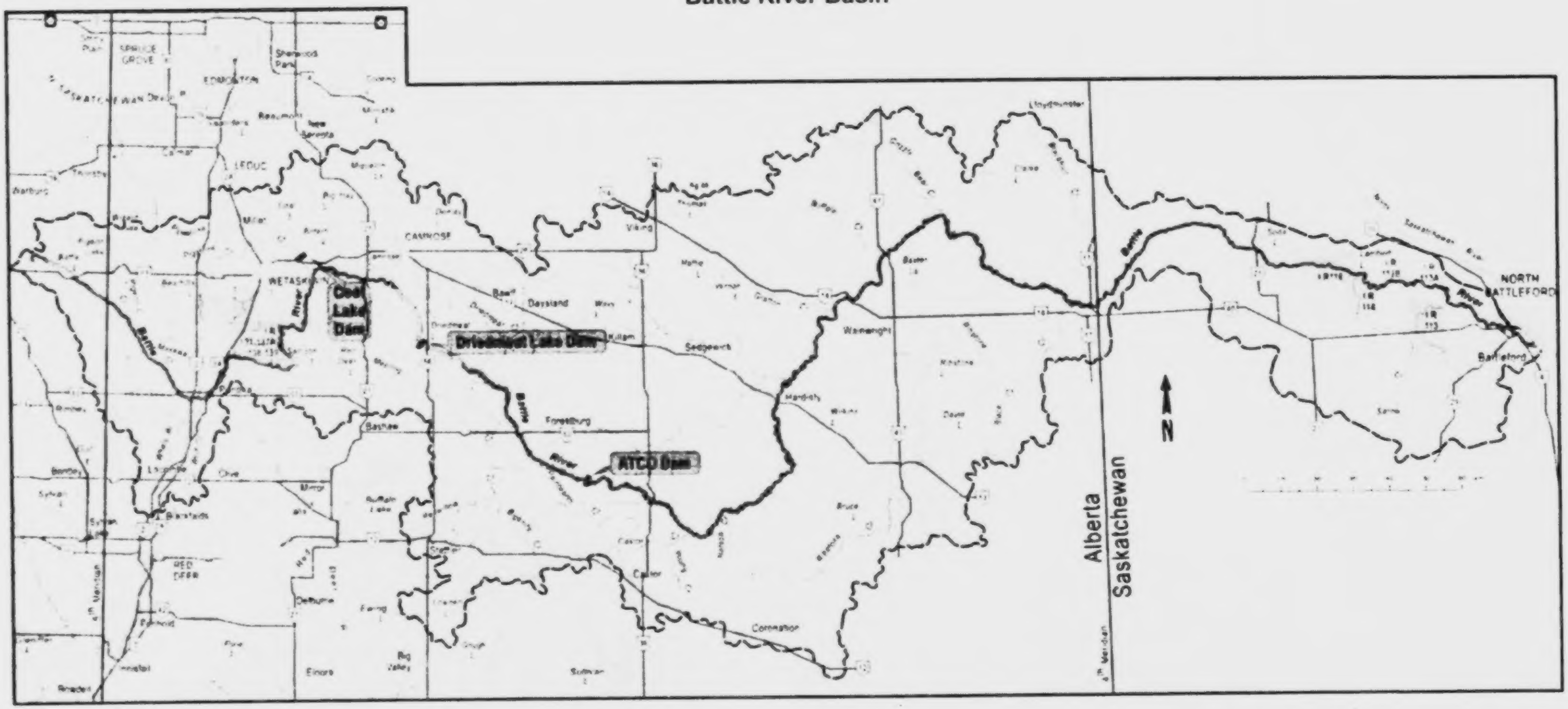
Figure 1.1

Battle River Basin



1 INTRODUCTION

In 2003 Alberta Environment commenced the development of Phase One of a Battle River Watershed Management Planning Process which is to be completed in 2006. Phase One consists of collecting baseline data, including a projection of water demands and consumption for the basin and an assessment of potential water supply options. Alberta Environment retained Watrecon Consulting to produce these water use projections.

1.1 The Study Area

The Battle River Basin (BRB) covers about 25,500 square kilometres in east Central Alberta. As shown in Figure 1.1, the upper reaches of the basin are situated just west of the Edmonton-Red Deer transportation corridor, near Winfield at Battle Lake. The river then travels east across Alberta for a distance of about 800 kilometres to the Saskatchewan border and eventually joins the North Saskatchewan River at the Town of Battleford in Saskatchewan.

In Alberta, the BRB lies entirely within the Central Parkland Natural Region. Within this region, there is a gradual transition from grassland with groves of aspen in the south to closed aspen forest in the north. Native vegetation is scarce because most land has been cultivated to grow agricultural crops. Most of the remaining natural land is on rougher terrain or poorer soils. Elevations range from about 1,100 metres in the headwater areas, dropping to just over 500 metres where the Battle River enters Saskatchewan. The region also contains numerous permanent streams. Lakes and a wide variety of permanent wetlands are also scattered throughout the region, and many are slightly to strongly saline.[1]

The water supply for the BRB is derived entirely from local surface runoff (rain and snow melt) and groundwater flows. Winter flows are minimal - only about one cubic metre per second (m^3/s) at the Saskatchewan border (see Figure 1.2). Flows increase to an average of nearly 25 m^3/s in mid-April, gradually decline to between five and 10 m^3/s during July and August and then drop steadily through the fall. A similar pattern occurs throughout the basin, although the flows are greatly reduced in the upper reaches.

Since river flows depend primarily on precipitation, there is tremendous variability in annual flows. Figure 1.3 shows annual flows at the Saskatchewan border since 1970. While the average annual flow for this period was about 247,600 cubic decametres (dam^3), this ranged from a high of nearly 1.3 million dam^3 in 1975 to only 43,700 dam^3 in 2002. The estimated median flow is 220,730 dam^3.

According to Alberta Environment, "Maintaining water quantity and quality in the Battle River Basin is an ongoing challenge given the river's natural low flow volumes, natural conditions of the basin and the cumulative impact of municipal, industrial and agricultural activities."[2]

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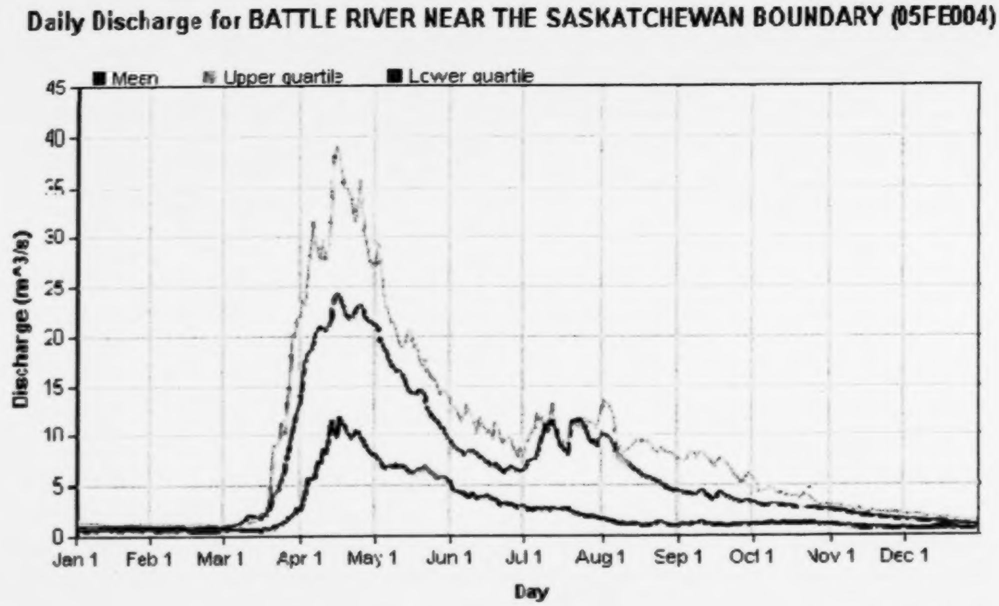
1 As reported at http://collections.ic.gc.ca/abnature/parklands/central.htm
2 As reported at http://www3.gov.ab.ca/env/water/regions/battle/index.html

Figure 1.2



Source: http://www.wsc.ec.gc.ca/staflo/index_e.cfm?cname=flow_daily.cfm

Figure 1.3

Source: http://www.pnr-rpn.ec.gc.ca/water/fa01/fa01d21/fa01s67.en.html

It also notes that "Increasing pressure on the Battle River's water supply is presenting a challenge for residents of the watershed and for Alberta Environment… As demand for water meets or exceeds the river's natural supply, social, ecological and economic limitations and issues become apparent."[3] Thus, Alberta Environment has embarked on the development of a water management plan to guide water management and to establish clear and strategic directions on how water in the BRB should be managed.

1.2 Approach

This assessment of water demand and supply in the BRB has involved four major tasks:

1. Establishing current water use patterns in the basin and correlating water use with population characteristics, economic development, and water use practices.
2. Predicting future population growth and economic development for the region.
3. Predicting future water use and consumption based on information from Task 2 combined with trends in water use technology, practices and policies.
4. Identifying various supply augmentation options that could alleviate potential shortages.

The assessment considers use of both surface water and groundwater in the basin and predictions are based on 10- and 25-year planning horizons.

This analysis of water demand relies predominantly on historic and existing information. In 1985 Stanley Associates Engineering Ltd. produced the *Battle River Basin Water Use Study* for Alberta Environment as part of basin planning activities at that time, and this report was used as the baseline for measuring changes in water use and identifying historical trends. The socio-economic profile for the basin, including agricultural information, was developed using data from Statistics Canada, Alberta Municipal Affairs, Alberta Agriculture, Food and Rural Development, and other sources, and adapting this data to reflect the watershed boundaries.

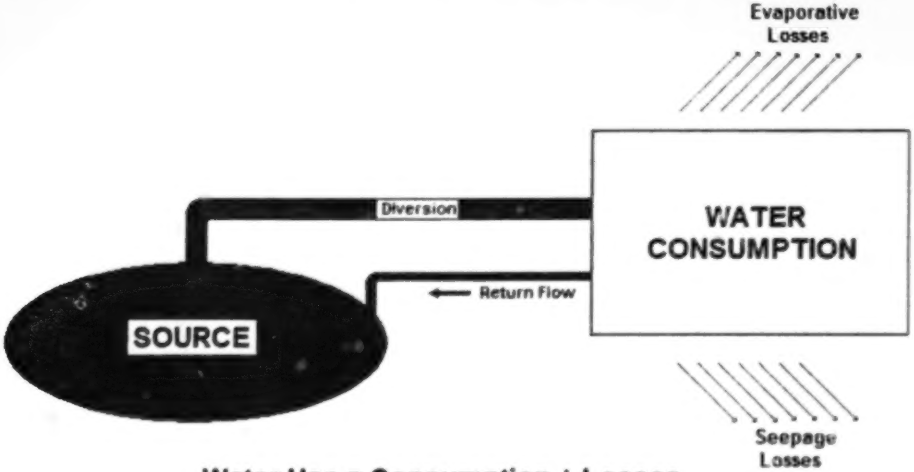
Initial projections of future water use for the municipal and agricultural sectors were prepared by combining information on existing water uses in the watershed with population and other basic indicators, and then making projections using simple assumptions about water use per capita and per farming operation. For the industrial sector, discussions were conducted with existing industrial users and regulatory authorities (Energy and Utilities Board) concerning future development in the region that might affect water demand.

The final projections of water use and consumption were developed by reviewing the draft projections with key water users in the region, especially the members of the Battle River Alliance for Economic Development, other municipal officials and economic development officers. These discussions allowed identification of other factors affecting water use and possible opportunities for future economic development and water demand. The final analysis also included a sensitivity analysis where the most critical assumptions affecting future water use were identified.

[3] Alberta Environment (2004). Terms of Reference. Battle River Watershed Management Planning Process: Phase 1.

Figure 1.4

Key Water Use Concepts and Terms



Water Use = Consumption + Losses

Return Flow = Diversion - Water Use

Table 1.1

Unit Conversion Factors

	Metric Units		Imperial Units
Length	1.0 millimetre (mm)	=	0.039 inches (in)
	1.0 metre (m)	=	3.281 feet (ft)
	1.0 kilometres (km)	=	0.621 miles (mi)
Area	1.0 hectare (ha)	=	2.471 acres (ac)
	1.0 square kilometre (km^2)	=	0.386 square miles (mi^2)
Volume	1.0 litre (l) = 0.001 cubic metre (m^3)	=	0.0353 cubic feet
		=	0.21998 gallons
	1.0 cubic metre (m^3)	=	35.315 cubic feet (ft^3)
		=	220.1 gallons
	1.0 cubic decametre (dam^3) = 1000 m^3	=	0.811 acre-feet (ac.ft.)

The assessment of possible future water supply options was also conducted using existing information on various schemes to divert water from either the North Saskatchewan River or the Red Deer River. Over the years various diversion schemes have been considered and they were reviewed to determine the extent to which they might address water demands in the basin. The role of demand management was also investigated to determine how this might affect future water use in the basin.

1.3 Terms and Definitions

In this report, several different terms are used to describe how water is used.

- Water allocation refers to the amount of water that can be diverted for use, as set out in water licences or the *Water Act*. These allocations include maximum amounts of water that can be withdrawn as well as a rate of withdrawal. An allocation is generally based on the maximum amount of water that an applicant expects will be required over the licencing period.
- Water diversion (or withdrawal) describes the amount of water being removed from a surface or groundwater source, either permanently or temporarily. Water diversions are typically less than water allocations because the full licensed amount is often not used.
- Water consumption is the amount of water that is used for the intended purpose, such as crop production, oilfield injection, etc., and is not available for reuse.
- Losses refers to water that is with drawn for a particular use but is lost, either due to evaporation or seepage, and is not available for immediate reuse.
- Return Flow is water that is returned to surface water sources after use and is available for reuse, although the water quality characteristics may have changed during use. Typical return flows include discharges from sewage treatment facilities, run-off from irrigated fields, and water discharged from cooling ponds.
- Water use is considered to be the combination of consumption and losses or, alternatively, represents the difference between the amount of water diverted and the return flow.

A graphic representation of these terms and their definitions in provided in Figure 1.4.

This report uses metric units of measurement. Imperial units of measure can be calculated using the conversion factors provided in Table 1.1.

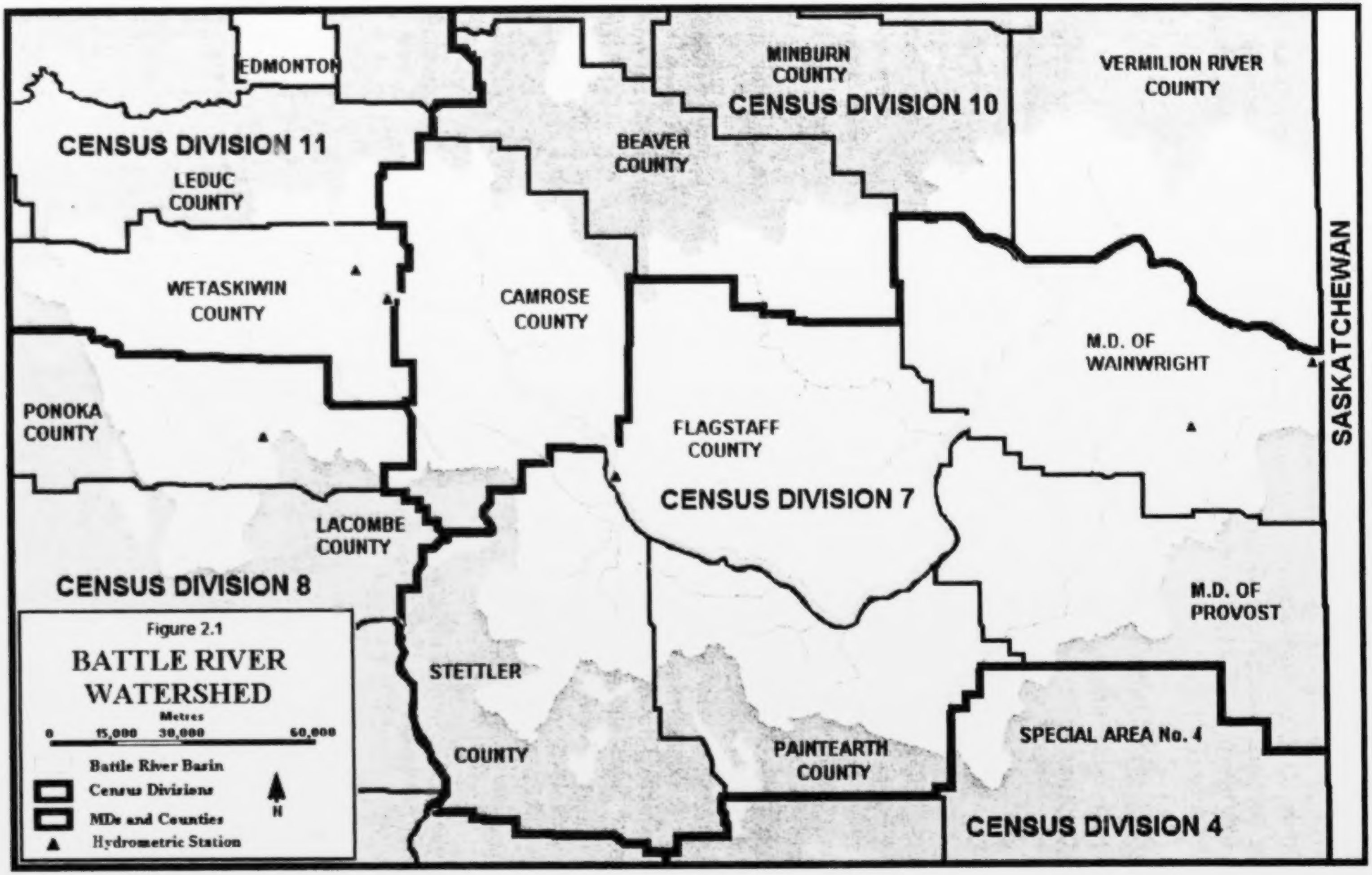


Figure 2.1
BATTLE RIVER WATERSHED

2 BASIN OVERVIEW

2.1 Study Area

As noted above, the BRB in Alberta covers approximately 25,500 square kilometres. Parts of the basin are situated in five census divisions and in 14 counties or municipal districts. As shown in Table 2.1 and Figure 2.1, nearly 55 per cent of the basin is located in Census Division 7 which includes the counties of Flagstaff, Paintearth, Provost, Stettler and Wainwright. Another 26 per cent of the basin is located in Census Division 10, while smaller portions fall in Census Divisions 4, 8 and 11.

Table 2.1

Municipal Districts and Counties in the Battle River Basin

Census Division	Municipal Districts and Counties	Area (Square Kilometres)	Per Cent of Basin
CD 4	Special Area 4	284	1.1%
	Sub-total	284	1.1%
CD 7	Flagstaff	4,145	16.2%
	Paintearth	2,286	8.9%
	Provost	2,003	7.8%
	Stettler	1,602	6.3%
	Wainwright	3,990	15.6%
	Sub-total	14,026	54.9%
CD 8	Lacombe	369	1.4%
	Ponoka	1,610	6.3%
	Sub-total	1,979	7.7%
CD 10	Beaver	1,013	4.0%
	Camrose	3,010	11.8%
	Minburn	313	1.2%
	Vermilion River	2,291	9.0%
	Sub-total	6,627	26.0%
CD 11	Leduc	312	1.2%
	Wetaskiwin	2,329	9.1%
	Sub-total	2,641	10.3%
Total		25,558	100.0%

Major population centres within the basin include the cities of Camrose, and Wetaskiwin and the towns of Ponoka, Lacombe, Stettler, Daysland, Hardisty, Killam, Sedgewick, Millet, Castor, Coronation, Viking, and Wainwright. Minor population centres include the villages of Bittern Lake, Hay Lakes, Bawlf, New Norway, Edberg, Ferintosh, Rosalind, Botha, Gadsby, Donalda, Chauvin, Edgerton, Irma, Alliance, Forestburg, Galahad, Heisler, Lougheed, Strome, Halkirk, Paradise Valley, Amisk, Hughenden, Czar, and Veteran. There are also some summer villages in the basin including Argentia Beach, Silver Beach, Poplar Bay, Grandview, Crystal Springs, Norris Beach, Ma-Me-O Beach, Sundance Beach, Itaska Beach, Golden Days. Also included in the Battle River Basin are the following First Nation Reserves: Louis Bull 138B, Samson 137, Samson 137A, Ermineskin 138, Pigeon Lake 138A, and Montana 139.

Table 2.2

Population of the Battle River Basin, by Reach, 2001

Basin	2001 Urban	2001 Rural	2001 Total	2001 % Urban	Change since 1996 Urban	Change since 1996 Rural	Change since 1996 Total
Upper Basin	46,056	20,397	71,382	64.5%	6.76%	1.23%	10.61%
Reserves			4,929				295.59%
Middle Basin	15,732	10,163	25,895	60.8%	-4.56%	-3.92%	-4.31%
Lower Basin	6,473	7,229	13,702	47.2%	0.14%	2.15%	1.19%
Battle River Basin	**68,261**	**37,789**	**110,979**	**61.5%**	**3.29%**	**-0.04%**	**5.56%**

Table 2.3

Employment in the Battle River Basin, by Reach, 2001

	Upper Basin	Middle Basin	Lower Basin	Battle River Basin
Agriculture/other resource-based industries	17.3%	34.4%	32.0%	23.5%
Manufacturing & construction industries	14.2%	9.0%	9.1%	12.2%
Wholesale and retail trade	16.3%	13.8%	10.8%	15.0%
Finance and real estate	3.8%	3.3%	3.1%	3.6%
Health and education	19.7%	14.0%	12.9%	17.4%
Business services	12.1%	11.9%	9.8%	11.7%
Other services	16.8%	13.9%	22.5%	16.8%

Table 2.4

Agriculture in the Battle River Basin, by Reach, 2001

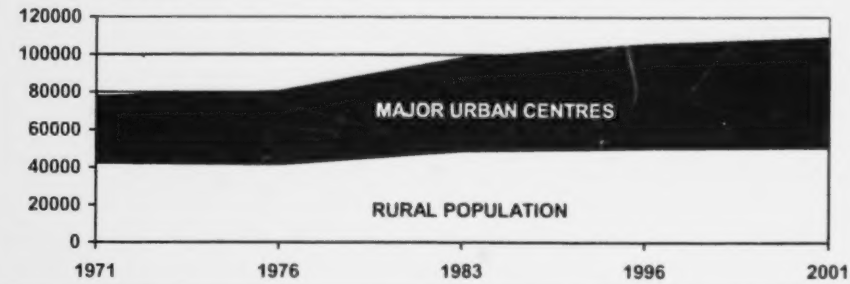
	Number of Farms #	Number of Farms % of Total	Average Size Acres	Total Area Acres	Total Area % of Total
Upper Basin	2,931	48.2%	557	1,633,642	28.5%
Middle Basin	2,022	33.3%	1,288	2,603,873	45.4%
Lower Basin	1,125	18.5%	1,332	1,498,599	26.1%
Battle River Basin	**6,079**	**100%**	**944**	**5,736,114**	**100%**

2.2 Population Base and Economic Activity

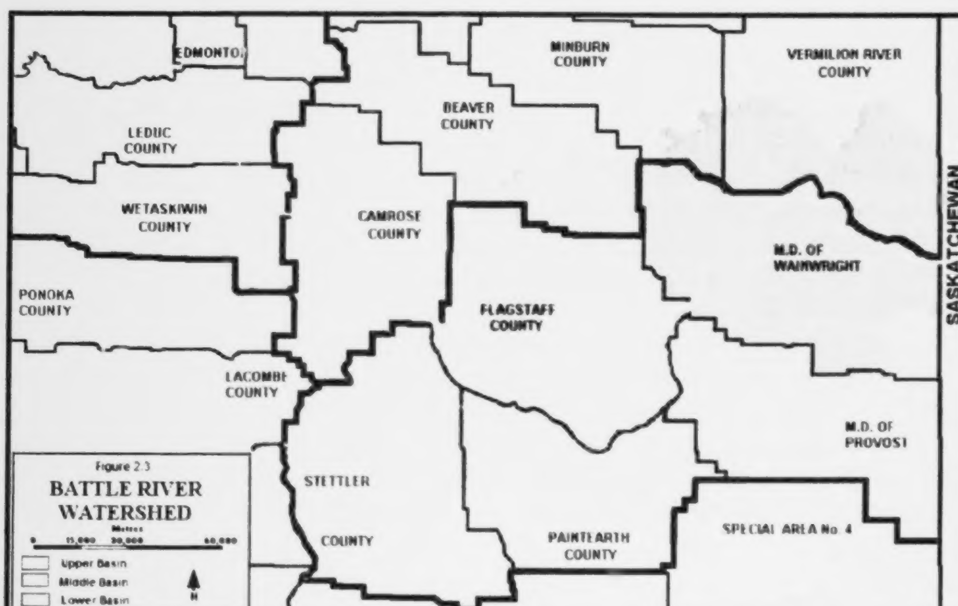
Census information indicates the total population of the Battle River Basin in 2001 was estimated to be about 111,000 people, including an estimated 4900 inhabitants of the six Reserves.[4] This represents a 16 per cent increase since 1983 and a three per cent increase since 1996. As shown in Figure 2.2, most of the population growth has occurred in the larger communities (those with a population of 1000 or more in 1983), while the rural population has remained relatively stable.

Figure 2.2

Population Growth in the Battle River Basin, 1971 to 2001



Based on demographic and economic characteristics, the BRB can be differentiated into three distinct reaches or sub-basins, which are shown in Figure 2.3. Some of the key characteristics differentiating these three areas are provided in Tables 2.2 to 2.4.



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4 It is not clear from the 1985 study whether the residents of the First Nations Reserves were included in the population estimates and associated estimates of water use. The methodology for calculating the regional population is described in Appendix A.

The upper basin is located in the Counties of Camrose, Lacombe, Ponoka, Leduc and Wetaskiwin. The downstream end of the upper basin closely approximates the location of the hydrometric station near Forestburg (see Figure 2.1). About 64 per cent of the basin population is located in the upper basin and is mostly urban (65 per cent). Since 1996, the total population of the upper basin has increased by more than 10 per cent. This includes a small increase in the rural population (one per cent), a major increase in the urban population (seven per cent) and a very significant increase in the population of the Reserves. The upper basin offers a greater diversity of employment than elsewhere in the BRB, reporting higher levels of employment in manufacturing and construction, trade, and health and education but only half as much employment in agriculture and other resource-based industries. However, nearly half (48 per cent) of farms in the BRB are located in the upper basin, but these farms tend to be small (557 acres) and feature more dairy, hog, other livestock, and specialty crops than elsewhere in the BRB.

The middle basin is situated in Beaver, Flagstaff, Paintearth and Stettler Counties, the MD of Provost, and Special Area #4. This part of the basin contains nearly one-quarter of the population of the BRB, and is about 60 per cent urban. However, both rural and urban populations have declined significantly since 1996. More than one-third of employment in the middle basin is related to agriculture and other resource-based activities, with lower levels of employment in personal and business services than in the upper basin. The Battle River Generating Station, near Forestburg, and the associated Paintearth Coal Mine are located in the middle basin. Nearly half the farmland in the BRB (45 per cent) is located in the middle basin and farms tend to be very large (1288 acres) and most are either cattle (beef) farms or raise grains and oilseeds.

The lower basin reach includes portions of the Counties of Minburn and Vermilion River and the MD of Wainwright. This part of the basin is the most sparsely populated with only 13 per cent of the population, the majority of which is rural (53 per cent). Since 1996 the urban and rural populations in the lower basin have increased slightly (by about one percent). Nearly one-third of employment is related to agriculture or other resource-based activities, but the "Other Services" sector is very large and likely reflects the effects of the military base at Wainwright. Farms in the basin tend to be very large (1332 acres) and are primarily cattle (beef) farms or grains/oilseed farms.

2.3 Water Supply

Residents of the BRB rely on water from several sources. The Battle River is the primary surface water source. As shown in Figure 2.4, six hydrometric stations in the basin monitor water flows at various points along the mainstem of the Battle River and its two major tributaries: Pipestone Creek and Ribstone Creek. The hydrometric station near Forestburg coincides with the approximate boundary of the upper basin, as defined using demographic data. The downstream boundary of middle basin lies just below the junction of Iron Creek and the Battle River.

The estimated natural flows at these stations were estimated as part of a recent study prepared for Alberta Environment.[5] This study combined information on observed flows, precipitation and historical water use to estimate the volumes of water that would naturally have been in the river and creeks. The resulting estimates are provided in Figure 2.4 which shows that the average flow at the Saskatchewan border is about 8.992 m^3/s. About 40 per cent of this flow originates in the headwater reaches, which includes the mainstem of the river above Gwynne and inflows from the Pipestone drainage. Natural flows in the upper basin (5.39 m^3/s) account for 60 per cent of the flow at the border while the middle basin only contributes 16 per cent (about 1.49 m^3/s). The balance of the natural flow at the Saskatchewan border (23 per cent) originates in the lower basin (2.11 m^3/s) including small inflows from Ribstone Creek.

Figure 2.4

Natural Flows and Use of Surface Water in the Battle River Basin

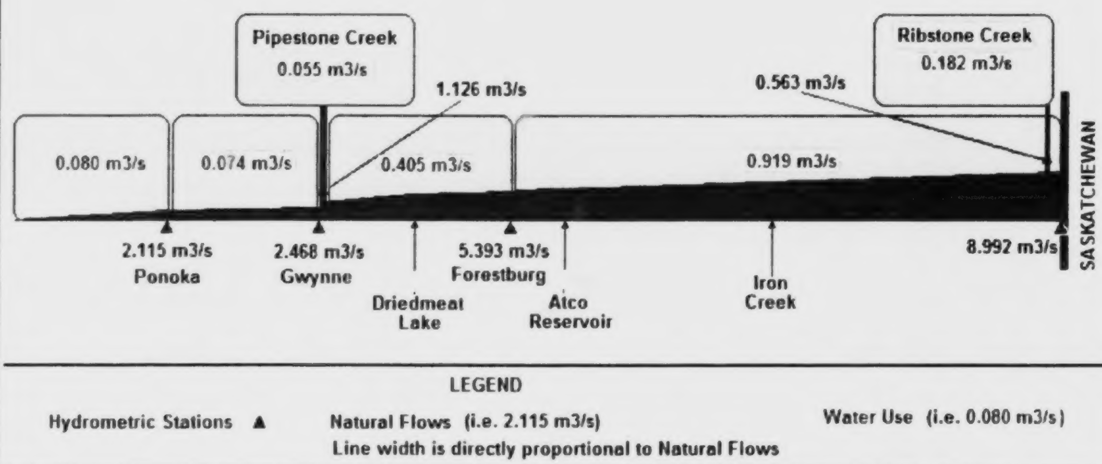


Figure 2.4 also provides information on estimated average water use in each portion of the basin above the six hydrometric stations. Total average water use is estimated to be 1.72 m^3/s, or about 19 per cent of average natural flow. More than half of this water use (64 per cent) occurs in the middle and lower basins.

While Figure 2.4 provides an overview of water supply and use based on flow, the corresponding volume information is summarized in Table 2.5. Under average conditions, the natural flow of the Battle River at the border is estimated to be 284,240 dam^3 while annual surface water use is about 54,809 dam^3. Annual flows are highly variable, however. For the period from 1912 to 2001 MPE found that the annual flow at the border ranged from a low of only 52,900 dam^3 (1.673 m^3/s) in 1930 to a high of 1,282,404 dam^3 (40.554 m^3/s) in 1974.

[5] MPE Engineering Ltd. and HART Water Management Consulting (2003). *Battle River Basin in Alberta Extension of Historical Natural Flow Database 1984 to 2001.*

Table 2.5

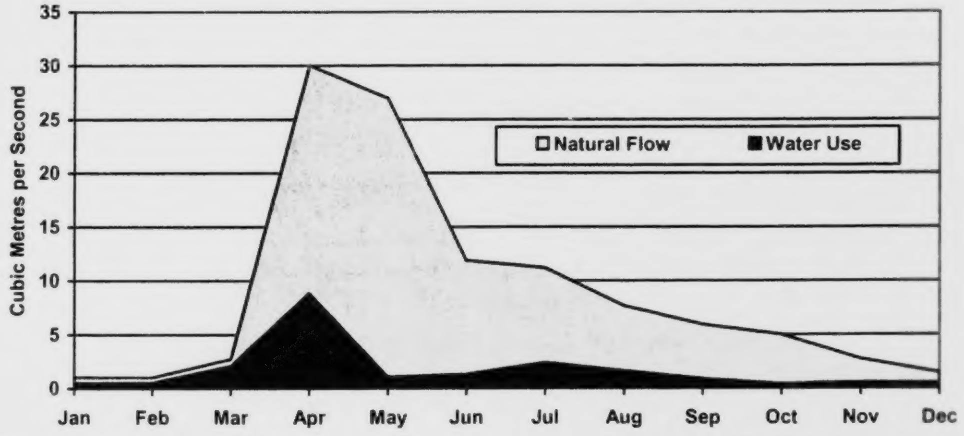
Estimated Average Natural Flow and Surface Water Use by Sub-Basin

Sub-Basin	Average Natural Flows		Average Water Use		
	Flows (m^3/s)	Volumes (dam^3)	Flows (m^3/s)	Volumes (dam^3)	Per Cent of Natural Flow
Upstream of Ponoka	2.115	66,846	0.080	2,516	3.8%
Ponoka to Gwynne	0.353	11,156	0.074	2,332	21.0%
Pipestone Creek	1.126	35,601	0.055	1,723	4.9%
Gwynne to Forestburg	1.799	56,868	0.405	12,765	22.5%
Upper Basin	5.393	170,471	0.614	19,336	11.4%
Forestburg to Border	3.036	95,979	0.919	29,006	30.3%
Ribstone Creek	0.563	17,790	0.182	5,747	32.3%
Middle/Lower Basin	3.599	113,769	1.101	34,753	30.6%
TOTAL	**8.992**	**284,240**	**1.715**	**54,809**	**19.1%**

Source: MPE Engineering Ltd. and HART Water Management Consulting (2003). *Battle River Basin in Alberta Extension of Historical Natural Flow Database 1984 to 2001.*

Figure 2.5

Estimated Natural Flows and Water Use by Month, Battle River Basin



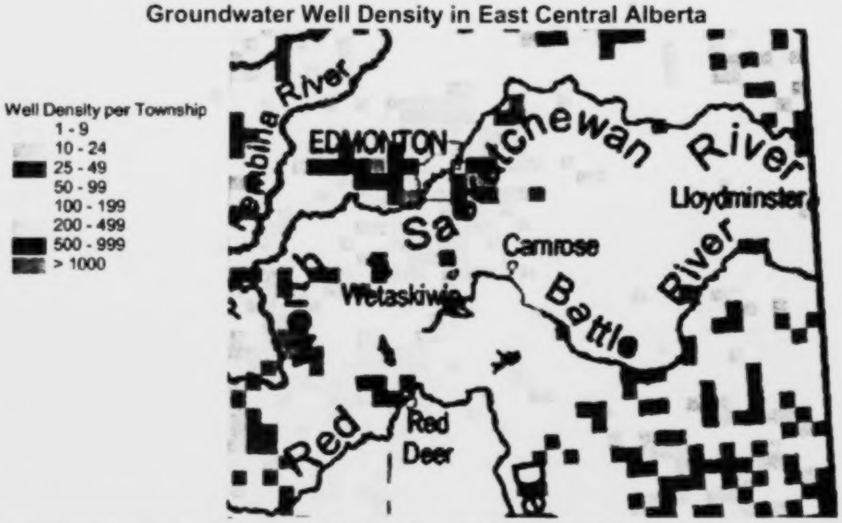
Source: MPE Engineering Ltd. and HART Water Management Consulting (2003). *Battle River Basin in Alberta Extension of Historical Natural Flow Database 1984 to 2001*

Monthly variations in estimated natural flows and water use are presented in Figure 2.5. Water use during the winter months consumes between a third and a half of natural flows in the Battle River, and increases to 75 per cent of flows in March. Natural flows peak in April and May as a result of spring snow-melt and water use increases significantly as storage reservoirs are filled. Natural flows gradually decline during the late spring and summer months and, at most, water use accounts for about 20 per cent of natural flow. This seasonal pattern is similar for each of the sub-basins.

Basin residents also make extensive use of groundwater. Figure 2.6 shows the density of groundwater wells per township (36 square miles) of land for the BRB and surrounding area. In the upper basin there are typically more than 100 wells per township and this number increases to 200 or more in the uppermost reaches of the basin. Well densities range between 10 and 100 per township in the middle and lower reaches of the basin. This pattern of well density reflects population density, and population densities are greatest in the upper basin.

Figure 2.6

Groundwater Well Density in East Central Alberta



Source: http://www3.gov.ab.ca/env/water/GWSW/quantity/learn/What/GW_GroundWater/GW_PDF/GW1_gw_wells.pdf

According to the Alberta Geological Survey (AGS), groundwater conditions in the region are highly variable, in terms of both quantity and quality.[6] In describing conditions in the Red Deer Area, which includes the Battle Basin, it noted that "anticipated groundwater yields range from over 500 imperial gallons per minute (igpm) to less than 1 igpm in the eastern part of the region, thus limiting development of groundwater supplies here for use as rural domestic, livestock and perhaps municipal supplies." AGS also commented that springs, salt deposits and flowing wells observed in the western part of the region indicates groundwater flow systems of local to regional scale. However, in the eastern portion of the region groundwater resources are poor as a result of low relief and limited groundwater discharge features.

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[6] Alberta Geological Survey, *Earth Sciences Report 1971-01, Hydrogeology of the Red Deer Area, Alberta* as reported at http://www.ags.gov.ab.ca/publications/ABSTRACTS/ESR_1971_01.shtml

Table 2.6

Summary of Surface Water Allocations in the Battle River Basin, 2004

Purpose		Number of Licences	Diversion (dam^3)	Water Use (dam^3)	Return Flow (dam^3)
Municipal & Residential	Urban	12	8,264	1,777	6,487
	Other	4	5,950	1,935	4,015
	Sub-total	16	14,214	3,712	10,502
Agriculture	Irrigation	176	12,197	10,485	1,712
	Feedlots	3	142	142	0
	Stockwatering	410	2,335	2,335	0
	Gardening	5	19	19	0
	Sub-total	594	14,693	12,981	1,712
Industry	Injection	9	7,529	7,389	140
	Gravel Washing	5	167	167	0
	Cooling	3	691,737	13,741	677,996
	Construction	2	19	19	0
	Other	7	659	609	50
	Sub-total	26	700,111	21,925	678,186
Wildlife Management	Fish Ponds	11	209	209	0
	Wetlands	115	17,629	16,890	739
	Sub-total	126	17,838	17,099	739
Water Management	Flood Control	11	1,557	1,101	456
	Sub-total	11	1,557	1,101	456
Recreation	Recreation	20	1,444	1,195	250
	Sub-total	20	1,444	1,195	250
Other	Sub-total	1	2	2	0
TOTAL	**Licences**	**794**	**749,859**	**58,015**	**691,845**
Traditional Agriculture Registrations		**6,645**	**1,955**	**1,955**	**0**
TOTAL			**751,814**	**59,970**	**691,845**

Source: Personal Communications, Todd Aasen, Water Administration Engineer, Central Region, Regional Services, Alberta Environment, November 2004.

Table 2.7

Summary of Surface Water Licences in the Battle River Basin, by Sub-Basin

	Number of Licences	Diversion (dam^3)	Water Use (dam^3)	Return Flow (dam^3)
Upper Basin	215	22,748	17,504	5,243
Middle/Lower Basin				
ATCO (cooling)	3	691,737	13,741	677,996
Other	475	21,698	19,537	2,162
Sub-total	478	713,435	33,278	680,158
Lower Basin	101	13,677	7,691	5,988
Battle River Basin	**794**	**748,859**	**58,015**	**691,845**

With respect to water quality, AGS notes that total dissolved solids (TDS) are generally less than 1000 parts per million (ppm) in the western portion of the area, increasing eastwards to over 2000 ppm in the southeast corner. According to the *Summary of Guidelines for Canadian Drinking Water Quality* (SGCDWQ), the recommended maximum concentration of TDS is 500 ppm. In general, AGS states that the quality of groundwater for drinking purposes is suitable to depths of 1000 feet in the western part of the Red Deer area, decreasing to only 300 feet in the eastern part.

2.4 Water Use

Residents and businesses in the basin draw water from surface and groundwater sources. Under the Alberta *Water Act* there are four ways in which a person can legally use water:

Household purposes	People owning or occupying land adjacent to surface water or under which groundwater exists can use up to 1250 m^3/yr without requiring a licence
Traditional agricultural use	Farmers owning land adjacent to surface water or under which groundwater exists could register to use up to 6250 m^3/yr with priority based on date when water first used. Applications for registrations had to be submitted prior to December 31, 2001 (within three years of the proclamation of the *Water Act*).
All other uses	A licence is required for all other diversions and the priority is based on the date the complete application was received.
Exempted agricultural use	The *Water Act* allows farmers who own land adjacent to surface water or under which groundwater exists and who used water for raising animals or applying pesticides prior to 1999, to use up to 6250 m^3/yr without having to acquire a licence. This use has no priority.

As of November 2004 some 794 licences and 6,674 traditional agriculture registrations had been issued for surface water use in the basin.[7] A summary of these is provided in Table 2.6. In total, these licences and registrations allow 751,825 dam^3 of surface water to be captured or diverted from the Battle River or its tributaries. This total actually represents more than 2.5 times the average natural flow of the Battle River at the Saskatchewan border. However, as will be explained in more detail later in the report, this apparent inconsistency reflects water licencing practices rather than actual water withdrawals. The more important measure is water use, and Table 2.6 shows that a maximum of 59,981 dam^3 of surface water can be consumed or lost.[8] Most diverted water (92 per cent) is returned to surface water bodies in the BRB.

Within the BRB the predominant surface water use in terms of withdrawal is industrial use, particularly the three licences issued for cooling at the ATCO thermal electric power facility near Forestburg. These three licences authorize withdrawals of 691,737 dam^3 and account for 92 per cent of licenced water withdrawals. However, 98 per cent of this water is returned to the Battle River after use. The ATCO licences only account for 23 per cent of licenced surface water use in the BRB.

[7] This number excludes 173 licences that have been issued but do not allocate water.
[8] This volume exceeds the water use estimate in Table 6 because it includes some licences issued since the study on natural flows was produced , excludes some licences that have since been canceled, and includes traditional agricultural use.

Table 2.8

Summary of Groundwater Allocations in the Battle River Basin, 2004

Purpose		Number of Licences	Diversion	Water Use	Return Flow
			dam^3		
Municipal & Residential	Urban	141	7,313	3,650	3,663
	Other	74	840	807	33
	Sub-total	215	8,153	4,457	3,696
Agriculture	Feedlots	58	618	618	0
	Stockwatering	1,106	4,852	4,852	0
	Gardening	9	27	27	0
	Sub-total	1,173	5,227	5,227	0
Industry	Injection	41	1,611	1,611	0
	Gravel Washing	8	236	230	6
	Water Hauling	13	345	345	0
	Other	29	113	113	0
	Sub-total	91	2,309	2,303	6
Water Management	Drainage	5	482	20	462
	Sub-total	5	482	20	462
Recreation		35	423	423	0
	Sub-total	35	423	423	0
Other		4	30	30	0
	Sub-total	4	30	30	0
TOTAL	**Licences**	**1,523**	**16,894**	**12,730**	**4,164**
Traditional Agriculture Registrations		**4,860**	**4,950**	**4,950**	**0**
TOTAL		**6,383**	**20,844**	**17,680**	**4,164**

Source: Personal Communications, Todd Aasen, Water Administration Engineer, Central Region, Regional Services, Alberta Environment, December 2004

Table 2.9

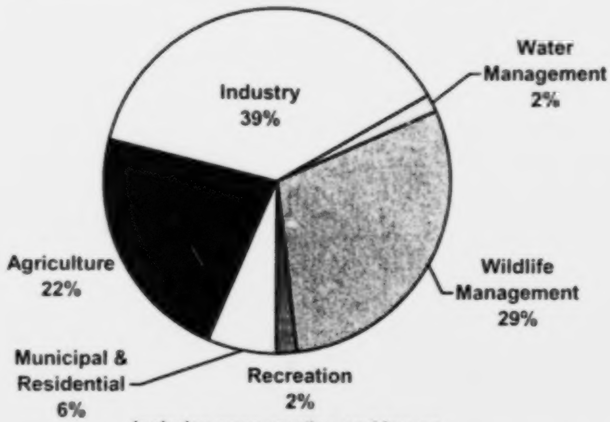
Summary of Groundwater Licences in the Battle River Basin, by Sub-Basin

	Number of Licences	Diversion	Water Use	Return Flow
		dam^3		
Upper Basin	832	9,625	6,458	3,167
Middle Basin	459	4,530	3,715	815
Lower Basin	232	2,740	2,558	182
Battle River Basin	**1,523**	**16,894**	**12,730**	**4,164**

The distribution of November 2004 surface licences by sub-basin is presented in Table 2.7. These estimates differ from Table 2.5 for several reasons. Table 2.7 has more current information on water licences but uses different watershed boundaries. Records provided by Alberta Environment define the upper basin as commencing at a point between the outlet of Driedmeat Lake and above the hydrometric station near Forestburg, so the upper basin is smaller than as shown in Figure 2.3. Despite these differences, Tables 2.5 and 2.7 both show that most water use occurs in the middle and lower basins. According to Table 2.7, 30 per cent of surface water use occurs in the upper basin, compared to 57 per cent in the middle basin and only 13 per cent in the lower basin. Table 2.7 also shows that the ATCO licences account for over 40 per cent of surface water use in the middle basin.

Figure 2.7

Licenced Surface Water Use, Battle River Basin



As shown in Figure 2.7, industrial water use, which includes gravel washing, oilfield injection and cooling, has the largest allocation of surface water in the BRB. It accounts for 38 per cent of licenced water consumption and losses. Agriculture, including irrigation, feedlots and stockwatering, is the second largest use of surface water (22 per cent). Wildlife conservation, which consists mainly of controlling spring run-off on tributary streams to establish wetlands as well as fish ponds, accounts for 30 per cent of water use. In comparison, municipal and residential use, recreation, water management and other uses collectively account for only 10 per cent of licenced water use.

As of December 2004 there were 1,523 active groundwater licences. These licences allow withdrawals of up to 16,895 dam^3 of groundwater, but there are few comprehensive records or studies that indicate how much of these allocations are actually being used on an annual basis. There were also 4,860 traditional agricultural registrations for groundwater allowing diversion and consumption of 4,950 dam^3.

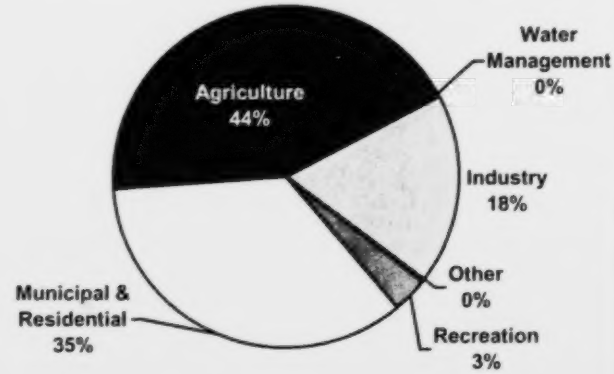
According to the licences, about 75 per cent of licenced groundwater (12,731 dam^3) can be consumed or lost, while 4,164 dam^3 is returned to surface water bodies. According to Table 2.8, most groundwater licences were issued for agricultural purposes, mainly stockwatering.

Agriculture accounts for 77 per cent of licenced groundwater licences and 44 per cent of groundwater use. Municipal and residential use of groundwater accounts for only 14 per cent of licences but nearly 35 per cent of licenced water use. About 90 licences have been issued for industrial water use, including injection, gravel washing and various other uses, and licenced annual use accounts for 18 per cent of water use. Figure 2.8 shows that recreation, drainage projects and other uses, accounted for an insignificant amount of groundwater use. Drainage projects can provide about 11 per cent of return flow from groundwater use, while municipal and residential uses account for nearly all other return flow.

Table 2.9 summarizes groundwater licencing by sub-basin using the same boundaries as for surface water (Table 2.7). Table 2.9 shows that water use is nearly equally split between the upper and the middle/lower parts of the basin. The upper basin accounts for 57 per cent of diversions and 51 per cent of water use, and much of this is for municipal and residential purposes. The lower basin accounts for 20 per cent of groundwater use while the middle basin accounts for 29 per cent.

Figure 2.8

Licenced Groundwater Use, Battle River Basin



Includes consumption and losses

Overall the Alberta Government has issued about 13,820 licences and registrations to use surface and groundwater in the BRB. These licences authorize the diversion of nearly 773,700 dam^3, but total water use (consumption and losses) can amount to only 77,652 dam^3. A summary of these allocations is provided in Table 2.10. The table shows that, as noted previously, the three licences issued to ATCO for its thermal electric power facility near Forestburg account for the vast majority of water allocations in the BRB. When these three licences are ignored, the remaining licences and registrations allow diversions of 81,922 dam^3 per year and consumption of nearly 63,911 dam^3.

Table 2.10

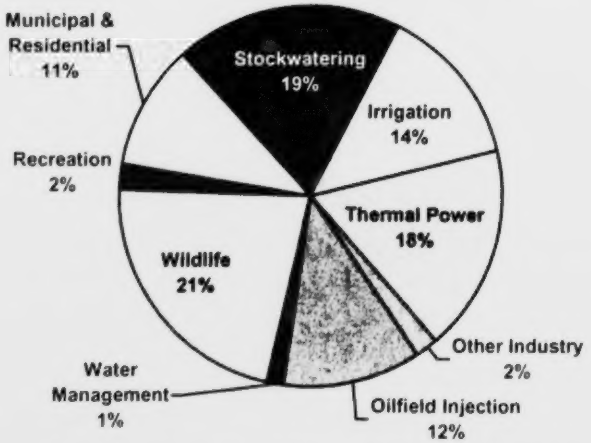
Summary of Water Allocations in the Battle River Basin, 2004

	Number	Diversion dam³	Water Use dam³	Return Flow dam³
ATCO surface water licences (cooling)	3	691,737	13,741	677,996
Surface Water Licences	791	58,123	44,276	13,849
Surface Registrations	6,645	1,955	1,955	0
TOTAL SURFACE WATER	7,439	751,815	59,972	691,845
Groundwater Licences	1,523	16,894	12,730	4,164
Groundwater Registrations	4,860	4,950	4,950	0
TOTAL GROUNDWATER	6,383	21,844	17,680	4,164
TOTAL	**13,822**	**773,659**	**77,652**	**696,009**

Figure 2.9 summarizes the total volumes of surface and groundwater that have been approved for use (consumption and losses) under licences and registrations. The largest approved users of water are wildlife propagation, stockwatering and thermal power (cooling), with each accounting for between 18 and 21 per cent of total use. The next largest water users are irrigation, oilfield injection and municipal and residential use; each use accounts for 11 to 14 per cent of approved water use. Use of water for recreation, water management and other industrial purposes cumulatively account for only five per cent of total approved use.

Figure 2.9

Approved Battle River Basin Water Use, 2004



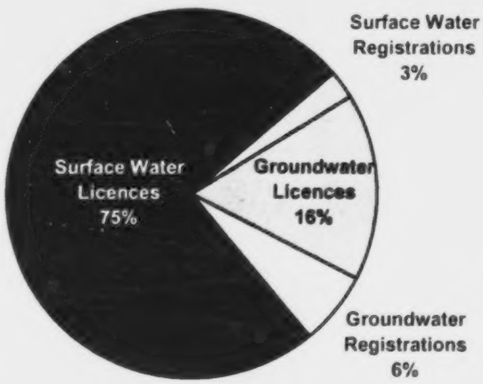
Includes consumption and losses for licences and registrations

Figure 2.10 summarizes approved water use according to the water source and type of authorization (licence or registration). It shows that surface water licences account for 75 per cent of the total, with surface water registrations accounting for another three per cent. About 16 per cent of approved water use is associated with groundwater licences, while groundwater

registrations account for six per cent. In combination, surface and groundwater registrations account for nine per cent of approved water use in the BRB.

Figure 2.10

Battle River Basin Water Use by Type of Approval, 2004



Includes consumption and losses for licences and registrations

3 MUNICIPAL AND RESIDENTIAL WATER USE

In 2001 the total population of the BRB was estimated to be about 111,000 people. About two-thirds of basin residents live in cities, towns and villages and draw water from some type of municipal infrastructure. The remainder consists of rural residents who have their own water sources.

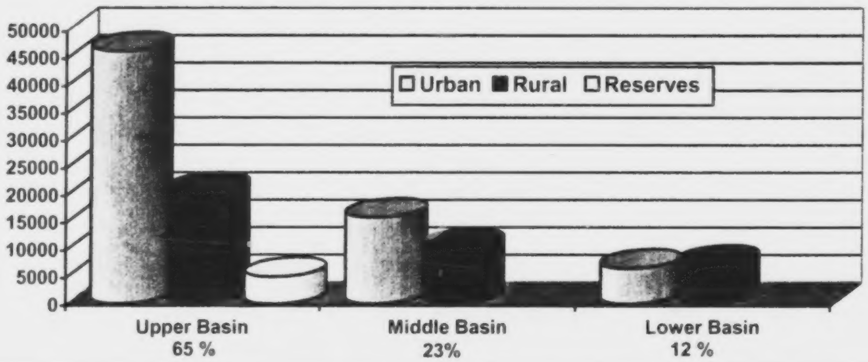
3.1 Existing Conditions

3.1.1 Population Characteristics

About 65 per cent of the population of the BRB in 2001 (approximately 71,400 people) lived in the upper part of the basin. This includes 46,100 people in cities, towns, villages or summer villages (urban), 20,400 rural residents, and 4,900 people on Reserves. The upper basin contains the majority of large population centres, including Camrose, Wetaskiwin, Ponoka, and Lacombe. As a result, the upper basin is more urban (65 per cent) than the rest of the basin (see Figure 3.1).

Figure 3.1

Distribution of Urban and Rural Population in the Battle River Basin



In 2001 the population of the middle basin was estimated to be 25,900 or 23 per cent of the population of the BRB. About 61 per cent of the population in the middle basin is considered urban, living in numerous towns and villages including Stettler, Coronation, Viking and Hardisty.

The lower basin accounts for only 12 per cent of the population of the BRB, with about 13,700 residents in 2001. The majority of the population in the lower basin is rural, with only 47 per cent living in towns or villages. Wainwright is the only significant population centre in the lower basin.

Since 1996 there has been considerable variability in the rates of population growth within the basin. Table 3.1 shows the urban[9] and rural populations for each of the 14 municipal districts

[9] Urban includes both major and minor population centres.

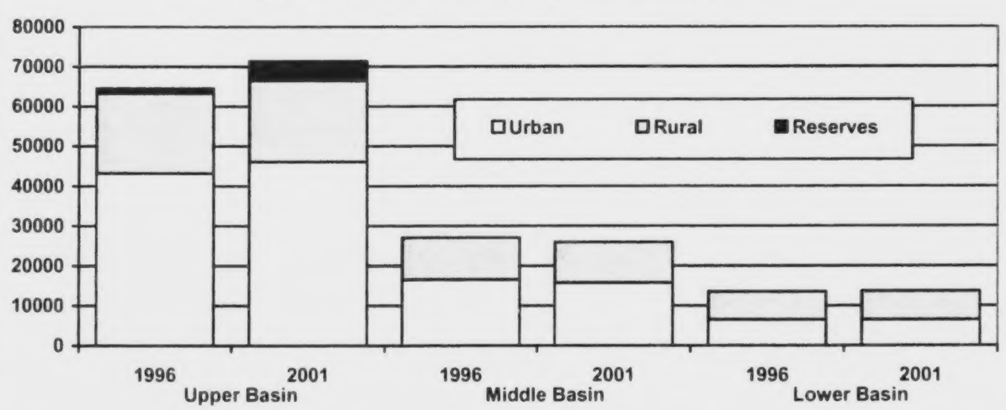
Table 3.1

Population of Municipal Districts and Counties in the Battle River Basin, 2001

	2001				Change since 1996		
Municipality	**Urban**	**Rural**	**Total**	**% Urban**	**Urban**	**Rural**	**Total**
Leduc County	172	1,416	1,588	10.8%	27.4%	1.9%	4.2%
County of Wetaskiwin	13,605	7,080	20,685	65.8%	3.2%	2.2%	2.9%
Ponoka County	6,330	4,638	10,968	57.7%	2.9%	6.5%	4.4%
Lacombe County	9,384	1,260	10,644	88.2%	12.7%	4.1%	11.6%
County of Camrose	16,565	6,003	22,568	73.4%	7.9%	-4.2%	4.4%
Reserves			4,929				295.6%
Upper Basin	**46,056**	**20,397**	**71,382**	**64.5%**	**6.8%**	**1.2%**	**10.6%**
Beaver County	1,052	1,580	2,632	40.0%	-2.7%	-0.3%	-1.2%
Special Area 4	292	94	386	75.7%	-7.9%	-7.7%	-7.9%
Flagstaff County	6,142	3,671	9,813	62.6%	-4.8%	-7.9%	-6.0%
County of Paintearth	1,954	1,442	3,396	57.5%	-13.8%	-5.4%	-10.4%
MD of Provost	621	1,404	2,025	30.7%	-7.5%	-2.6%	-4.1%
County of Stettler	5,671	1,971	7,642	74.2%	-0.5%	1.7%	0.1%
Middle Basin	**15,732**	**10,163**	**25,895**	**60.8%**	**-4.6%**	**-3.9%**	**-4.3%**
MD of Wainwright	6,321	3,918	10,239	61.7%	0.0%	4.6%	1.7%
County of Minburn	0	354	354	0.0%		-2.6%	-2.6%
County of Vermilion River	152	2,957	3,109	4.9%	7.8%	-0.4%	0.0%
Lower Basin	**6,473**	**7,229**	**13,702**	**47.2%**	**0.1%**	**2.2%**	**1.2%**
Battle River Basin	**68,261**	**37,789**	**110,979**	**61.5%**	**3.39%**	**-0.04%**	**5.56%**

Figure 3.2

Changes in Urban and Rural Populations, 1996 to 2001



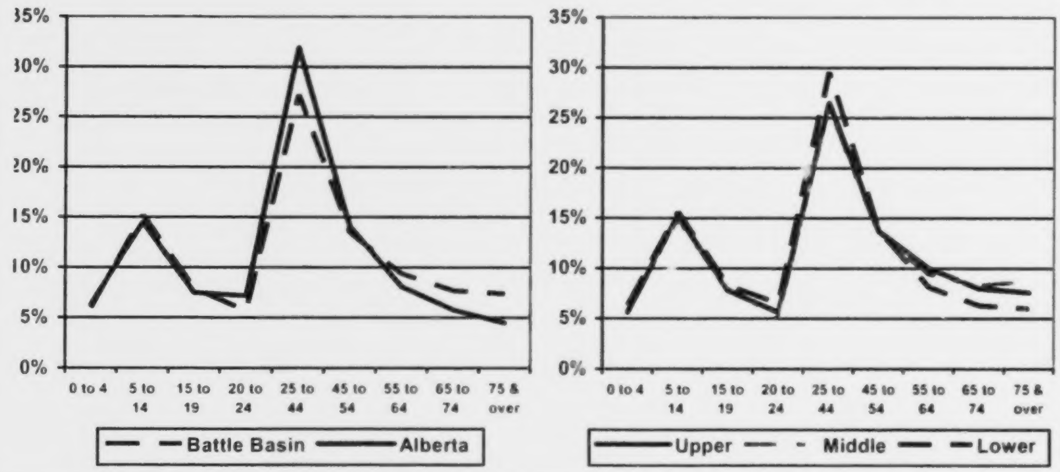
and counties within the BRB in 2001. It also shows the rates of population change since 1996. The table shows that the population of Lacombe County grew by nearly 12 per cent while the population of the County of Paintearth dropped by more than 10 per cent. Overall, the population of the BRB increased by about 5.6 per cent between 1996 and 2001, though the rural population decreased slightly. During the same period, the Alberta population increased by 10.3 per cent.

Analysis of the municipal data shows some distinct differences in regional population characteristics. As shown in Figure 3.2 the urban and rural populations in the upper reach of the BRB both increased between 1996 and 2001, and the overall rate of increase was relatively large (more than 10 per cent). The urban and rural populations in the lower basin also increased since 1996, but the rate of increase was low (only about one percent). In the middle reach of the BRB both the rural and urban populations declined by about four per cent.

In terms of age characteristics, residents of the BRB tend to be older than Albertans in general. Figure 3.3 shows the percentage of the population in various age categories. Compared to Alberta, there were lower percentages of people aged 20 to 44 in the BRB but more people aged 55 and older. In 2001 people aged 65 or older comprised 10 per cent of the Alberta population but 15 per cent of BRB residents. Within the BRB there are also some differences. Residents of the lower basin tended to be slightly younger, with the age composition resembling the provincial average. In comparison, residents of the middle basin were the oldest, with the highest proportion of people over the age of 55. More than 17 per cent of residents of the Middle basin were age 65 or older in 2001.

Figure 3.3

Age Characteristics of Residents of the Battle River Basin



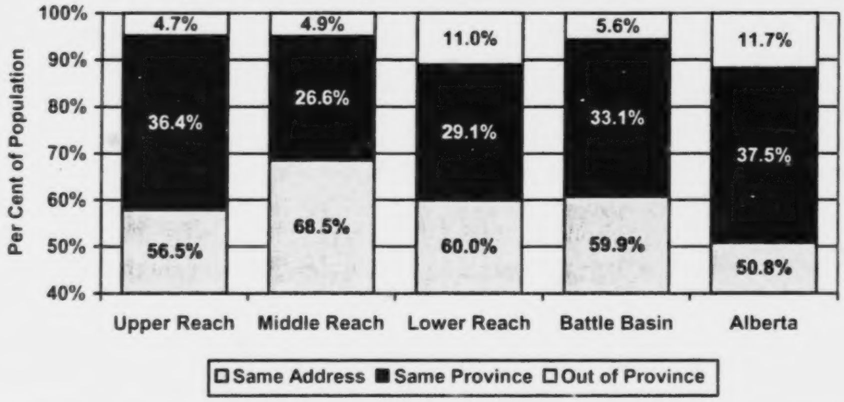
These age characteristics are believed to be tied to changes in the economic base of the different parts of the BRB. In the lower basin, the Canadian Armed Force base at Wainwright tends to

attract a younger population. At the same time, younger families are leaving the middle basin because of limited employment opportunities, leaving behind an older population.

Figure 3.4 summarizes the mobility of the regional populations based on whether individuals had moved within the five years prior to the 2001 Census. Within the BRB about 59 per cent indicated that they had not moved, compared to 51 per cent of Albertans. This indicates that the regional population tends to be less mobile and more stable than rest of the province. Similarly, only six per cent of the regional population indicated that it had moved into the region from outside Alberta since 1996; the corresponding number for Alberta was double this number (12 per cent).

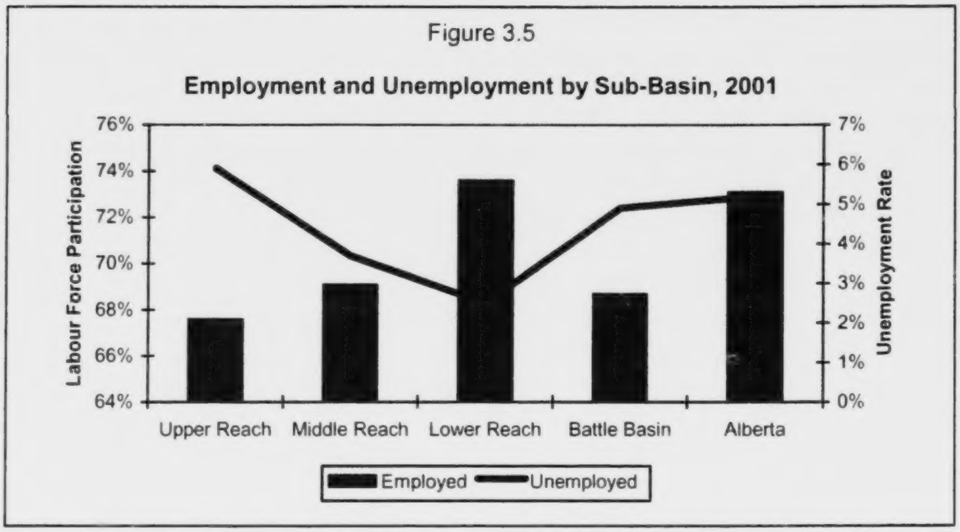
Figure 3.4

Population Mobility Since 1996 by Sub-Basin

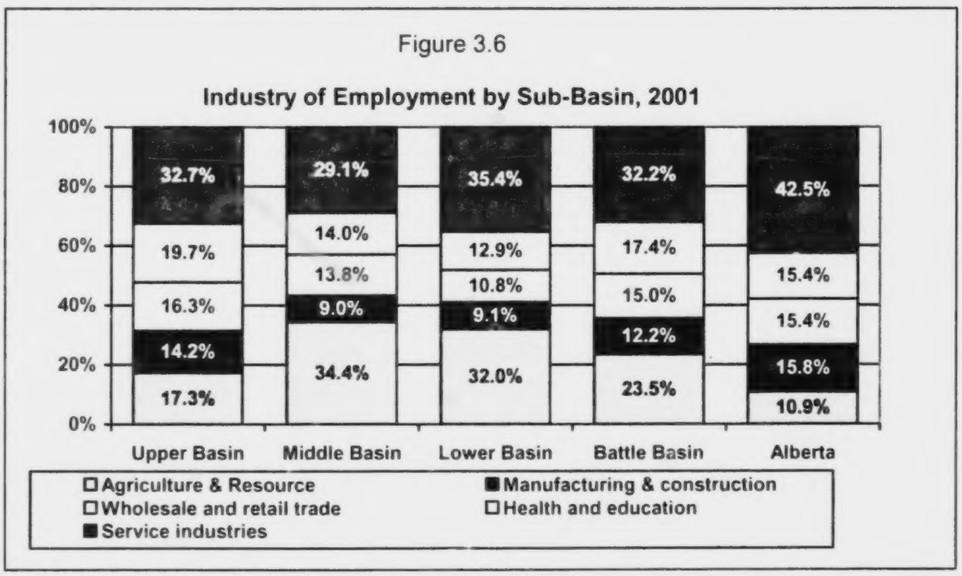


There is also some variability within the BRB. Figure 3.4 shows that the residents of the middle basin are the least mobile: nearly 69 per cent had resided at the same address since 1996 and less than five percent had moved into the region from outside Alberta. The lower basin shows the highest proportion of non-Albertans moving into the region since 1996 (11 per cent) and this reflects the in-migration associated with the Armed Force base at Wainwright. The upper basin reported the highest percentage of people moving into the region from other parts of Alberta (36.4 per cent).

In terms of employment, fewer residents of the BRB are active in the workforce than in Alberta. Figure 3.5 shows that, in 2001, about 73 per cent of Albertans aged 15 and older were active in the workforce and, of these, 5.2 per cent were unemployed. In the BRB only 68.7 per cent were active in the workforce and this reflects the age characteristics in Figure 3.3; more BRB residents are over 65 years of age and are less likely to be working or seeking work. The unemployment rate in the BRB (4.9 per cent) was comparable to that of Alberta. Within the basin, the highest labour force participation occurred in the lower basin, which generally has a younger population, and the unemployment rate was only 2.5 per cent. The labour force participation rates were lowest in the upper basin, at just under 68 per cent. Unemployment rates in the upper basin (5.9 per cent) were nearly double those of the middle basin (3.7 per cent).



The employment characteristics for the BRB were previously summarized in Table 2.3. Figure 3.6 compares the regional employment to that of Alberta, according to the industry of employment. Within the BRB agriculture and other resource based industries accounted for more than twice as much employment as occurs in Alberta. Agriculture and other resource-based industry accounted for 23.5 per cent of employment in the BRB, and this ranged from 17.3 per cent in the upper basin to 34.4 per cent in the middle basin. Employment in other primary industries, such as manufacturing and construction, was significantly less in the middle and lower basins (nine per cent) than elsewhere in the basin (12.6 per cent) or Alberta (15.8 per cent). Similarly, the proportion of people in the BRB employed in retail and wholesale trade (15 per cent) was slightly less than for the province (15.4 per cent), and was much less in the lower basin (10.8 per cent).

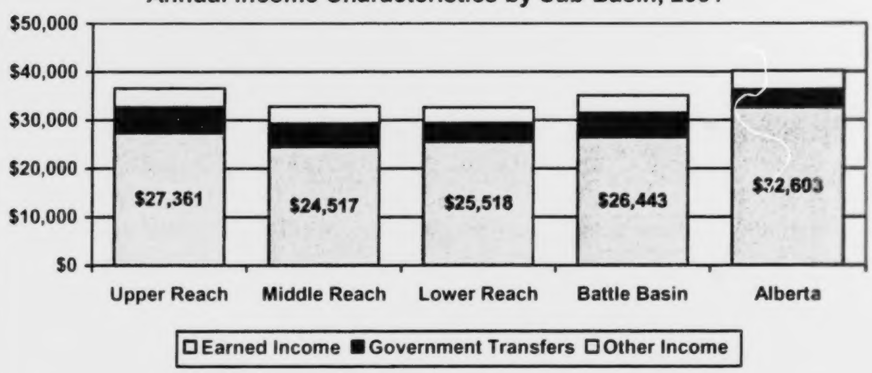


Employment in health and education industries in the BRB (17.3 per cent) was higher than for Alberta (15.4 per cent), and accounted for 19.4 per cent of employment in the upper basin. Regional employment in the services industries, which includes finance and real estate, business services and other services (32.2 per cent), was significantly lower than in Alberta (42.5 per cent). Within the BRB employment in the services industries ranged from a low of 29.1 per cent in the middle basin to a high of 35.4 per cent in the lower basin.

Average incomes in the BRB were lower than the provincial average. As shown in Figure 3.7 earned incomes in the BRB were nearly 20 per cent less than the Alberta average of $32,603 reported for 2001. Within the BRB, earned incomes were about four percent higher than average in the upper basin and eight per cent lower in the middle basin. Figure 3.7 also shows that BRB residents are more reliant on income from government transfers than Albertans in general. The highest percentage of income from government transfers occurred in the upper basin.

Figure 3.7

Annual Income Characteristics by Sub-Basin, 2001



In summary, the population of BRB cannot be considered as a homogenous group in terms of demographic or economic characteristics or their current and future uses of water:

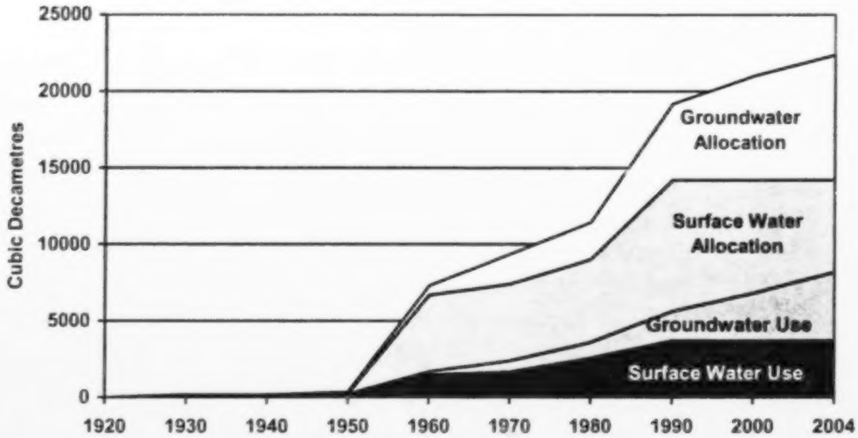
- The upper basin can be characterized as having a dynamic and diversified economy that has generated higher levels of in-migration and population growth, with higher incomes than in the rest of the BRB.
- In contrast, the population of the middle basin is gradually shrinking as younger people leave in search of employment. This part of the basin has the lowest levels of in-migration, the highest reliance on agriculture for employment, the lowest incomes, and the greatest proportion of the population aged 65 and older.
- The economic base of the lower basin is less diversified than that of the upper basin, and appears to be largely based on agriculture and activity at the Canadian Armed Forces base at Wainwright. The population of the lower basin tends to be younger than elsewhere in the BRB. It has the highest levels of in-migration and low unemployment, and has experienced minor population increases.

3.1.2 Water Licence Information

The issuing of licences for municipal and residential purposes really commenced in the 1950s, although some small licences were issued as early as the 1920s. Figure 3.8 shows that nearly one-third of existing allocations (32 per cent) for both surface water and groundwater were issued during the 1950s. During the 1960s and 1970s, there was a gradual increase in the amount of water allocated for municipal and residential purposes, but there was a significant increase during the 1980s. By 1990 about 86 per cent of existing licences had been issued. Since then, allocations of surface water have remained static at a total allocation of about 14,200 dam^3. Increased demand for municipal and residential purposes since 1990 has focused on groundwater, with licenced use of groundwater increasing by 3,196 dam^3 since 1990.

Figure 3.8

Historical Trends in Municipal Water Allocation and Use



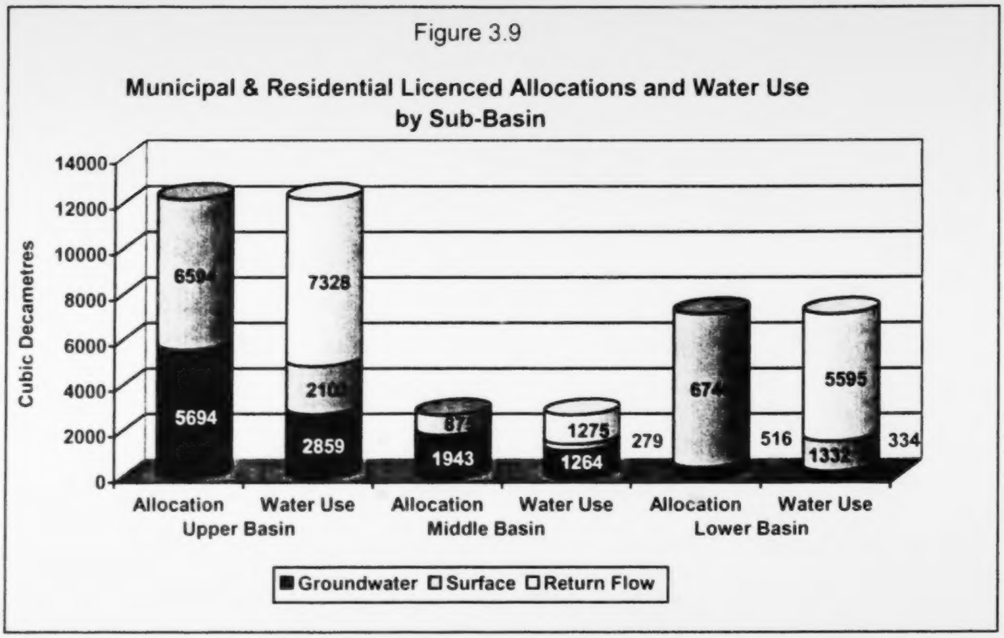
At the present time some 231 licences have been issued for municipal and residential water use in the BRB. Table 3.2 provides a summary of these licences by source of supply (surface or groundwater) within the basin. In general, "urban" purposes consist of licences issued to cities, towns and villages. "Other" purposes include licences issued to individuals or groups, including Hutterite colonies and schools, which are not considered "household purposes" or require amounts of water in excess of 1250 m^3/year, as described in Section 2.4. Table 3.2 does not include water used by individuals for "household purposes", which does not require a water licence.

Within the BRB, licences issued to municipalities and others authorize the withdrawal of 22,367 dam^3 of water per year for municipal and residential purposes. Of this, 64 per cent is for surface water and 36 per cent for groundwater. Municipal and residential users in the upper basin are authorized to withdraw 12,288 dam^3; this represents 55 per cent of approved withdrawals in the BRB. As shown in Figure 3.9, withdrawals of surface water account for just over half (54 per cent) of the total allocation in the upper basin.

Table 3.2

Summary of Municipal and Residential Surface Water and Groundwater Allocations and Use

	Purpose	Number of Licences	Diversion dam^3	Water Use dam^3	Return Flow dam^3
Upper Basin	Urban	7	5,669	1,177	4,492
	Other	2	925	925	0
	Surface Water	9	6,594	2,102	4,492
	Urban	57	5,295	2,492	2,803
	Other	26	399	367	33
	Groundwater	83	5,694	2,859	2,835
	Total	92	12,288	4,961	7,328
Middle Basin	Urban	4	868	273	596
	Other	1	6	6	0
	Surface Water	5	875	279	596
	Urban	62	1,701	1,023	679
	Other	37	242	242	0
	Groundwater	99	1,943	1,264	679
	Total	104	2,818	1,543	1,275
Lower Basin	Urban	1	1,727	328	1,399
	Other	1	5,019	1,004	4,015
	Surface Water	2	6,746	1,332	5,414
	Urban	22	317	135	182
	Other	11	199	199	0
	Groundwater	33	516	334	182
	Total	35	7,262	1,666	5,595
Battle River Basin	Urban	12	8,264	1,777	6,487
	Other	4	5,950	1,935	4,015
	Surface Water	16	14,215	3,713	10,502
	Urban	141	7,313	3,650	3,663
	Other	74	840	807	33
	Groundwater	215	8,153	4,457	3,696
	Total	231	22,368	8,170	14,198



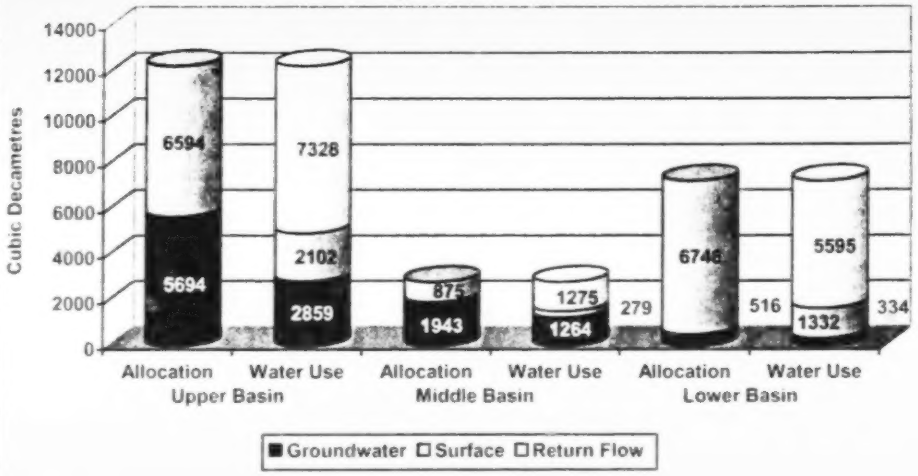
In the middle basin, licenced allocation for municipal and residential purposes only total 2,818 dam^3; this represents about 13 per cent of municipal and residential allocations in the BRB. Groundwater accounts for 69 per cent of water allocations in the middle reach. Water allocations for municipal and residential water use in the lower basin total 7,262 dam^3, consist almost entirely for surface water (93 per cent) allocated to Wainwright and the Canadian Armed Forces Base, and account for 32 per cent of allocations in the BRB.

Figure 3.9 also provides information on water use authorized by licences for municipal and residential purposes. Overall, about 36 per cent of water allocations can actually be consumed or lost and the balance is returned to surface water bodies in the BRB. Total water use for municipal and residential purposes in the BRB, as authorized in licences, is 8,169 dam^3. About 45 per cent of this is surface water. Sixty-one percent of licenced water use for municipal and residential purpose is authorized in the upper basin, 19 per cent is in the middle basin, and 20 per cent is in the lower basin.

The licence information in Table 3.2 indicates that about 70 per cent of municipal and residential allocations are for "urban" purposes. This category includes all licences issued to cities, towns, villages, and regional governments that provide community water services. A total of 153 licences have been issued for "urban" purposes. Many communities have more than one licence, and sometimes have licences for both surface water and groundwater. Total allocations for "urban" purposes are 15,577 dam^3 with approved water use amounting to 5,427 dam^3. A summary of licence information and municipal water use characteristics for cities, towns, villages in the BRB is provided in Table 3.3. It should be noted that, while Stettler is located in the BRB, it draws its water from the Red Deer River. Similarly, Viking is now drawing treated water from CU Water Limited's pipeline along Highway 14. And, in the near future, Lacombe, Ponoka, and possibly the Montana Band will obtain treated water from the City of Red Deer.

Figure 3.9

Municipal & Residential Licenced Allocations and Water Use by Sub-Basin



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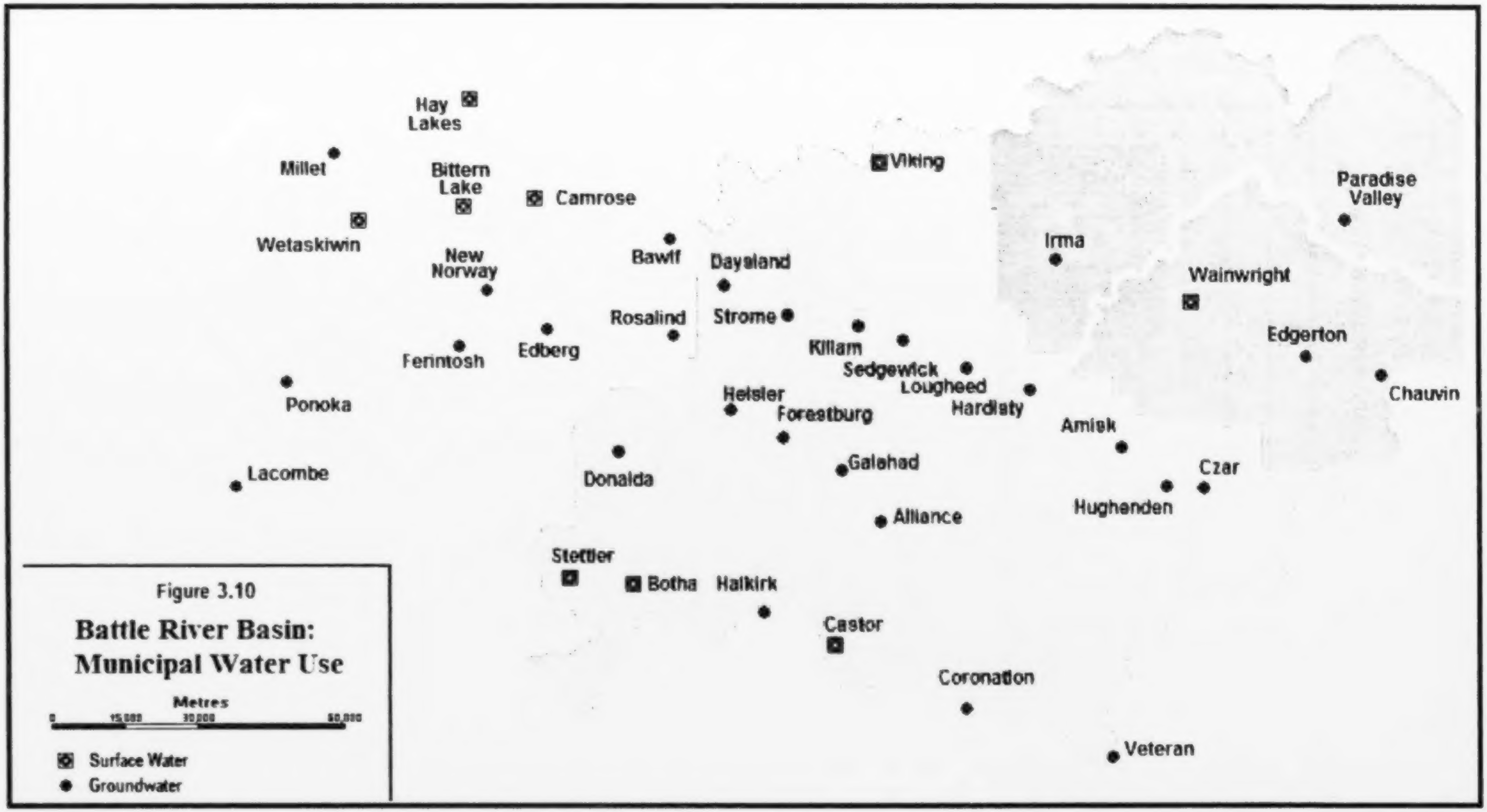


Figure 3.10

Battle River Basin: Municipal Water Use

Table 3.3

Summary of Urban Water Supply Characteristics, Battle River Basin

	2001 Population	Water Source	No. of Licences	Allocation	Water Use	Reported Use 2004			Per Cent of Licence	Comments
				dam^3	Dam^3	Type	dam^3	l/d/capita		
Camrose	14,854	Driedmeat Lake Camrose Creek	3 1	3084 185	525 185	Raw Treated	2176 1997	401 368	71%	
Wetaskiwin	11,154	Coal Lake Groundwater	2 3	2467 163	617 33	Raw Treated	1847 1488	454 366	75%	The groundwater licences is no longer used.
Lacombe	9,384	Groundwater	11	2805	1460	Raw	1117	344	40%	Switching to treated water from Red Deer in 2005
Ponoka	6,330	Groundwater	15	1647	475	Treated	839	363	51%	Switching to treated water from Red Deer in 2005
Stettler	5,215	Red Deer River	1	1700	340	Raw Treated	987 889	518 467	58%	
Wainwright CFB Wainwright	5,117	Battle River	1	1726 5020	1332 1004	Treated	857 243	459	17%	Data for 2004/05
Samson Reserve	4,929	Groundwater	9	423	423	No information				Parts of the Reserve will be switching to treated water from Red Deer in 2005
Millet	2,037	Groundwater	2	85 68*	17	Raw Treated	234 231	314 310	153%	* Application for additional water licence in process
Viking	1,052	Iron Creek	2	548	159	No information				Now served from Hw 14 regional pipeline by CU Water
Killam	1,004	Groundwater	3	214	214	Treated	183	500	86%	
Castor	935	Castor Creek	1	247	81	Raw	163	479	66%	Quantity concerns during droughts
Coronation	902	Groundwater	4	342	68	Raw	197	598	58%	Water quality concerns (TDS)
Forestburg	870	Groundwater	3	178	178	Raw	110	348	62%	Data for 2003
Sedgewick	865	Groundwater	9	227	227	Raw	124	392	55%	
Daysland	779	Groundwater	4	167	33	Raw	101	357	60%	Data for 2002
Hardisty	743	Groundwater	5	99 37*	20	Raw Treated	174 148	643 547	128%	* Application for additional water licence in process
Irma	435	Groundwater	8	148	30	Raw	49	311	33%	Data for 1999
Edgerton	403	Groundwater	1	43 34*	26	Raw	38	256	88%	* Application for additional water licence in process

Table 3.3 (continued)

Summary of Urban Water Supply Characteristics, Battle River Basin (continued)

	2001 Population	Water Source	No. of Licences	Allocation	Water Use	Reported Use 2004			Per Cent of Licence	Comments
				dam^3	Dam^3	Type	dam^3	l/d/capita		
Chauvin	366	Groundwater	1	60 23*	60	Raw	75	561	90%	* Application for additional water licence in process
Bawlf	362	Groundwater	2	26 30*	11	Raw	44	333	79%	* Application for additional water licence in process
Hay Lakes	346	Camrose Creek	1	88	29	Raw	61	479	69%	Possible regional water line from Edmonton.
Veteran	292	Groundwater	2	47	9	Raw	50	457	106%	
New Norway	292	Groundwater	3	48	10	Raw	35	328	73%	
Strome	273	Groundwater	3	74	15	Raw	34	341	46%	
Hughenden	235	Groundwater	2	63	63	Raw	33	387	52%	
Donalda	230	Groundwater	8	53 29*	33	No information				* Application for additional water licence in process
Lougheed	228	Groundwater	4	62	62	Raw	70	836	113%	Data for 2003 Application for additional water licence in process
Bittern Lake	221	Groundwater	2	47	47	Raw	16	199	34%	Regional line from Camrose.
Czar	205	Groundwater				No information				Residents have individual licences
Rosalind	190	Groundwater	5	41	30	Treated	29	415	71%	
Botha	186	Stettler				Raw	21	312		Community obtains treated water from Stettler.
Heisler	183	Groundwater	3	37	37	Raw	21	309	57%	
Amisk	181	Groundwater	2	23	5	Treated	22	331	96%	
Alliance	171	Battle River Groundwater	1 2	74 42	10 42	Raw Treated	39 38	621 612	93%	Switched to a groundwater system in 2002.
Galahad	161	Groundwater	3	43	9	Treated	22	1252	51%	
Paradise Valley	152	Groundwater	2	37	7	Treated	27	297	46%	
Ferintosh	150	Little Beaver R. Groundwater	1 5	31 15	6 15	Raw	12	211	80%	Switched entirely to groundwater in 2000. Data for 2003
Edberg	150	Groundwater	3	16	16	Raw	11	206	69%	
Halkirk	117	Groundwater	2	21	4	Treated	14	324	67%	
Gadsby	40	Stettler				Raw	18	1252		Water from Stettler.

Licences issued for "urban" purposes account for three per cent of surface water use in the BRB and 29 per cent of groundwater use.

As noted in Table 3.2, about 34 per cent of licenced municipal and residential water use is for "other" purposes. As shown in Table 3.4, most of these licences were issued to various water cooperatives. These include 15 Hutterite colonies, the Department of National Defence at Wainwright, and various municipal governments. These cooperatives account for 51 of the "other" licences, 92 per cent of water allocations, and 82 per cent of water use. Also included in the "other" municipal category are licences issued to institutions (Alberta Hospital at Ponoka) and various schools (Lakeland College and Canadian Union College). These licences account for four percent of "other" allocations and nine per cent of other municipal water use. Various "other" uses included licences issued to various subdivisions, condominium associations, water haulers and camps. Collectively these "other" municipal and residential uses account for three per cent of licenced surface water use in the BRB and six per cent of groundwater use.

Table 3.4

Composition of "Other" Municipal and Residential Allocations and Use

Purpose	Number of Licences	Diversion dam³	Diversion %	Water Use dam³	Water Use %	Return Flow dam³
Cooperatives - Surface	4	5,950	87.6%	1,935	70.6%	4,015
Cooperatives - Groundwater	47	325	4.8%	325	11.8%	
Institutions	3	163	2.4%	130	4.8%	33
Schools	6	121	1.8%	121	4.4%	
Subdivisions	6	40	0.6%	40	1.5%	
Other	12	191	2.8%	191	7.0%	
TOTAL	**78**	**6,790**		**2,742**		**4,048**

It should be noted that the Department of National Defense operates the water treatment plant that also serves the Town of Wainwright. The allocation for the Department of National Defense allows withdrawals of 5019 dam^3 and use of 1004 dam^3 and has been treated as a municipal water licence in Table 3.3. The remaining allocations for "other" uses allow 1,771 dam^3 of withdrawals and 1,738 dam^3 of consumption.

3.1.3 Water Use Estimates

Table 3.3 also provides information on estimated actual water use for each of the cities, towns and villages in the Battle River Basin for 2004. This information was taken from annual water use reports filed for 2004, although 2003 and 2002 information was used in a number of cases where 2004 reports had not yet been filed. There was no information for four communities. Although most communities reported water use in terms of average daily raw water withdrawals, some communities reported monthly totals and some provided information on volumes of treated water. Monthly data were added to produce annual totals, which were then compared to licence information to determine what proportion of existing allocations are currently being used. The annual data were also converted to estimates of average per capita daily water use based on 2001 population estimates. In a letter dated April 19, 2005, Alberta Environment noted that, for six communities using groundwater, additional allocations are being processed or have been issued and the additional licences are included in Table 3.3.

The data show that for the most part, communities are only using a portion of their licenced allocations. Table 3.5 shows that communities that draw groundwater are currently using 56 per cent of their allocations and this proportion is fairly consistent throughout the basin. On average, 41 per cent of municipal surface water allocations from the BRB are currently being withdrawn, although this varied from 72 per cent in the upper basin to only 13 per cent in the lower basin. On average, municipal water withdrawals in the BRB amounted to about 416 litres per person per day (l/p/d), although surface water users typically reported slightly higher use (433 l/p/d) than groundwater users (378 l/p/d).

Table 3.5

Estimated 2004 Municipal Water Withdrawals

		Actual Withdrawals (dam^3)	2001 Population	Average Daily Per Capita Use (l/c/d)	Per Cent of Allocation
Upper Basin	Surface Water	4,099	26,575	423	72%
	Groundwater	2,380	18,895	345	50%
Middle Basin	Surface Water	163	935	479	66%
	Red Deer River	1,026	5,441	517	60%
	Groundwater	1,267	7,439	467	76%
Lower Basin	Surface Water	894	5,117	479	13%
	Groundwater	189	1,502	344	55%
TOTAL	Surface Water	5,156	32,627	433	41%
	Groundwater	3,836	27,836	378	56%
	Red Deer Basin	1,026	5,441	517	60%

Allocation utilization was highest for surface water communities in the upper basin (72 per cent of allocation) and groundwater users in the middle basin (71 per cent). Table 3.5 shows that those communities that rely on surface water imports from the Red Deer River (Stettler, Botha and Gadsby) reported withdrawing 25 per cent more water (517 l/p/d) than communities that rely on BRB water.

Figure 3.11 provides additional information on municipal water user by communities in the BRB according to the proportion of their water allocations currently being used. Of 32 communities that had licences and reported water withdrawals, the vast majority (25) are currently using less that 80 per cent of their current allocations. A small number (four) reported using more than their current allocations, although they are in the process of acquiring additional entitlements. It is noteworthy that most of the communities in the upper basin, which accounts for the largest population, are currently using between 70 and 79 per cent of their allocations. However, six communities in the middle basin are currently drawing more than 80 per cent of their allocations.

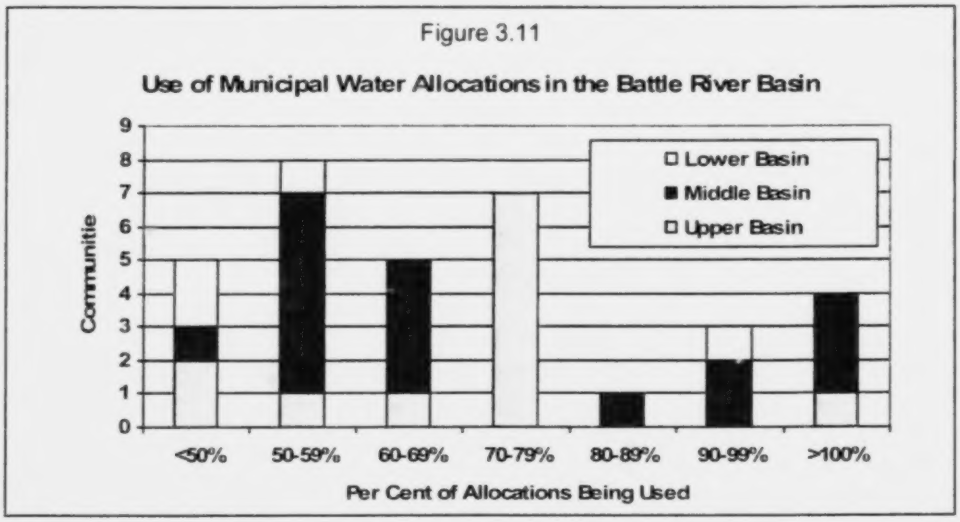
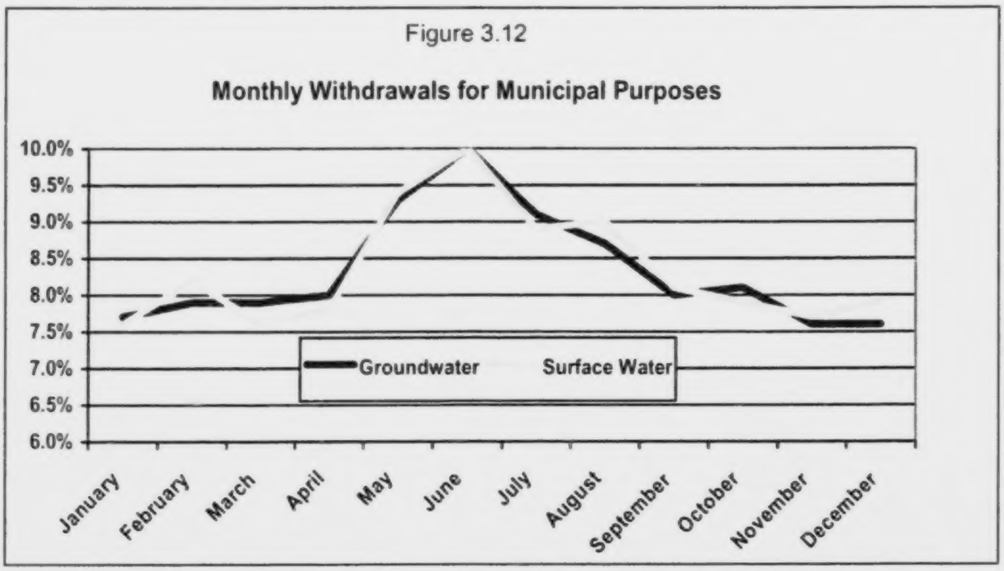


Figure 3.12 shows the monthly pattern of municipal withdrawals for both surface and groundwater use. The monthly pattern is essentially the same regardless of source: water use increases starting in April, peaks in June, declines gradually through September, and then remains fairly stable during the winter months.



Actual water use by municipalities is more difficult to estimate because it must be calculated as the difference between reported withdrawals and reported wastewater discharges, and there are a number of problems with the discharge data. First, only 21 of 39 communities in the BRB provided wastewater discharge information for 2003 or 2004. Second, the reported discharges sometimes exceed reported withdrawals. While this can partially be explained by smaller communities discharging their lagoons every second or third year, it is unclear why Wainwright, Camrose or Ponoka reported returning more water than they withdrew. Third, the reported discharge data, which are often based on estimated reductions in the volume of sewage lagoons,

are less accurate than water withdrawal information. Despite these problems, the estimates of discharges for those communities that submitted reports for 2004 are summarized in Table 3.6, but should be interpreted with caution.

Table 3.6

Reported 2004 Municipal Water Consumption

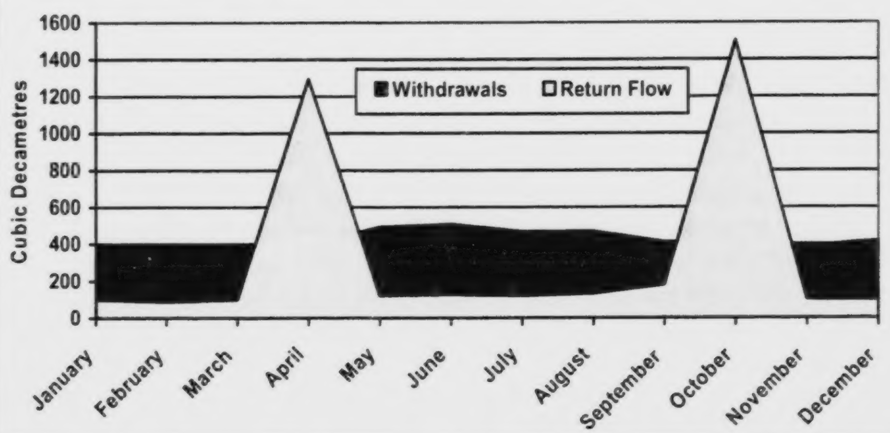
Source	Basin	Communities Reporting			Withdrawals	Discharges	Per cent of	Consumption
		Total	Reporting	% of Population	dam^3	dam^3	Withdrawals	dam^3
Surface	Upper	4	3	99%	3,754	2,919	71%	1,164
	Middle	1	1	100%	163	99	60%	65
	Lower	1	1	100%	894	955	107%	-62
	Total	**6**	**5**	**99%**	**4,811**	**3,973**	**76%**	**1,167**
Imports	Middle	4	2	83%	1,008	800	79%	208
Ground Water	Upper	8	4	95%	2,261	2,965	131%	-704
	Middle	17	9	42%	504	213	42%	291
	Lower	4	1	24%	75	5	7%	69
	Total	**29**	**14**	**77%**	**2,840**	**3,183**	**112%**	**-343**

Table 3.6 shows that the discharge data for municipalities using surface water is nearly complete, with five of six communities representing 99 per cent of the population providing reports. These reports suggest that, in total, actual water use accounted for 1,167 dam^3 or 24 per cent of withdrawals. On a per capita basis, actual water use is estimated to be 99 l/c/d. However, as noted above, wastewater discharges for both Camrose and Wainwright exceeded reported withdrawals.

The seasonal pattern of water withdrawals and wastewater discharges from municipalities using surface water in the BRB is provided in Figure 3.13. However, this reflects when water is treated for use rather and may not accurately portray when water is actually withdrawn from surface water bodies. For example, the raw water storage at Wainwright is filled from the Battle River during May through October and the water is then drawn from storage for treatment on a monthly basis, as required.

Figure 3.13

Monthly Municipal Surface Water Withdrawals and Returns



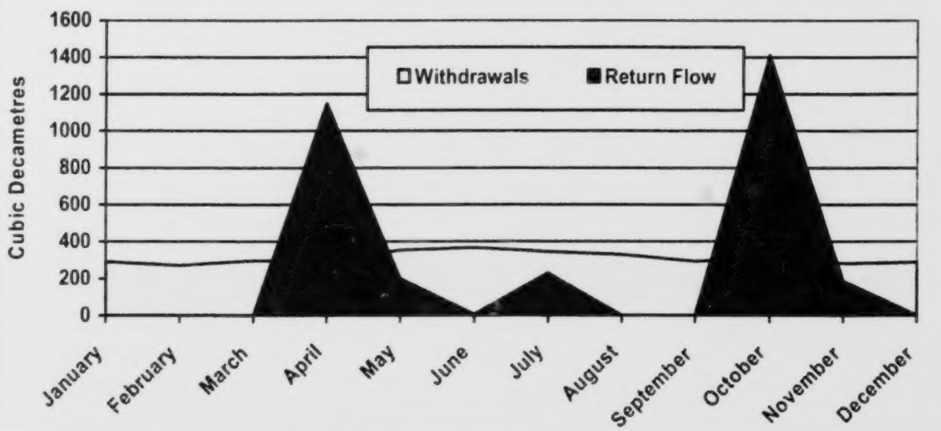
While Figure 3.13 shows that about 25 per cent of the water withdrawn for municipal use is treated and discharged on a continuous basis, the large communities actually store the treated wastewater in lagoons and then release it to surface water sources in the spring and fall. For the smaller communities, the lagoons are the primary method of water treatment and the lagoons are emptied in the spring (April) and fall (October).

The information for communities that rely on water imported from other basins is less complete, with data from only two of three communities that currently rely on water from the Red Deer River and no data for Viking, which obtains treated water from the North Saskatchewan River. Available data indicate that, for 83 per cent of the population that uses imported water, 800 dam^3 of the 1,008 dam^3 drawn from the Red Deer River are returned to Stettler wetlands. Estimated consumption is 208 dam^3 and represents 20 per cent of withdrawals or about 105 l/c/d.

Water discharge information is only available for only 14 of 29 communities using groundwater or 42 per cent of the municipal population that uses groundwater. The data show that reported discharges exceeded groundwater withdrawals by 343 dam^3. Consumption of groundwater is clearly understated; four of the smaller communities in the middle basin reported no water discharges in 2004. Part of the problem is that Ponoka reported discharging 191 per cent of withdrawals. Thus, the reported data on municipal groundwater use must be interpreted with caution. For purposes of forecasting actual groundwater consumption, it is assumed that 25 per cent of withdrawals are actually consumed. This proportion is slightly higher than for surface water use because evaporative losses will be higher because lagoons in smaller communities may be emptied less frequently. It should be noted that estimated return flows from municipal groundwater users represent additions to surface water in the BRB and may affect the calculations of instream flows.

Figure 3.14

Monthly Municipal Groundwater Withdrawals and Returns



The season pattern of municipal groundwater withdrawals and returns is presented in Figure 3.14. While the pattern of groundwater withdrawals is relatively consistent from month-to-month, treated wastewater is only periodically discharged from lagoons. These discharges

typically occur in April and October, although some communities reported pumping out lagoons in May, July and November.

3.1.4 Summary

Existing water use data does not allow a completely accurate assessment of municipal and residential water use in the BRB. However, based on the information contained in Tables 3.3, 3.5 and 3.6, an overall assessment of municipal water use can be developed. This assessment is presented in Table 3.7 and relates to the 60 per cent of the BRB population that draws water from one of the communities identified in Table 3.3. The data suggest that communities are currently withdrawing about 47 per cent of their licenced allocations. Estimated water use is only 26 per cent of licenced municipal water use. About 23 per cent of withdrawals are being consumed, although the accuracy of the consumption estimates is suspect. This means that municipal consumption accounts for 11 per cent of allocations and added about 4,681 dam^3 of water to surface flows through discharges of treated water from groundwater (3,981 dam^3) and surface water imports from other basins.

Table 3.7

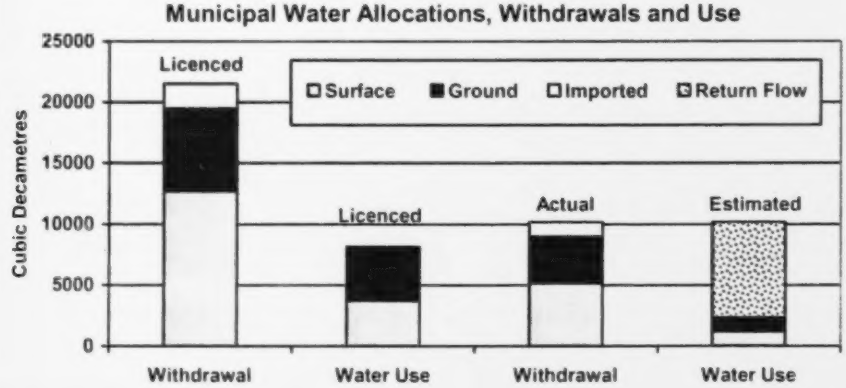
Summary of Municipal Water Allocations, Withdrawals and Consumption

	2001 Population	Allocation dam³	Allocation L/c/d	Withdrawals dam³	Withdrawals L/c/d	Withdrawals % of Allocation	Consumption dam³	Consumption L/c/d	Consumption % of Withdrawal
Surface	32,627	12679	1065	5,156	433	41%	1175	99	23%
Ground	27,836	6802	669	3,836	378	56%	965	95	25%
Red Deer RIver	5,441	1700	856	1026	517	60%	208	105	20%
N. Sask. River	1,052	333	867	157	410	47%	35	91	22%
TOTAL	66,956	21,514	880	10,175	416	47%	2,383	98	23%

On a per capita basis, the data suggest that existing municipal licences have allocated about 880 litres per day, and 416 litres are actually withdrawn. Actual consumption only amounts to 98 litres per person per day; this represents water that is not returned to surface water sources for reuse. The data in Table 3.7 are presented graphically in Figure 3.15.

Figure 3.15

Municipal Water Allocations, Withdrawals and Use

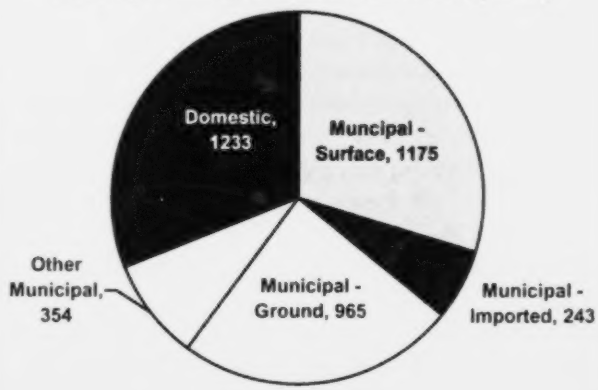


With respect to licence issued for "other" municipal purposes, a review of water licence records was not undertaken. For purposes of predicting current use by "other" municipal uses it was assumed that only 20 per cent of licenced allocations (1,771 dam^3) are currently being consumed.

Overall, total water consumption for municipal, residential and household purposes in the BRB is estimated to be about 3970 dam^3. This is based on a basin population of 111,000 people consuming an average of 98 litres per person per day. The estimated distribution of water use is provided in Figure 3.16.

Figure 3.16

Municipal and Residential Water Use (dam3)



The figure shows that about 30 per cent of municipal and residential water use in the BRB is by people living in communities using surface water. About six per cent is surface water imported from other basins. People residing in communities that used groundwater accounted for 24 per cent of the total. "Other" municipal purposes are responsible for nine per cent of the total; 52 per cent of this "other" use is surface water. The balance (31 per cent or 1233 dam^3) is from individuals drawing water for domestic purposes (no licences required) or from other sources (bottled or trucked water).

The use of 98 litres per person per day is significantly lower that estimated water use in other areas. For example, the water use assessment for the South Saskatchewan River Basin (SSRB) planning study determined that, based on questionnaires from 1997 to 1999, average withdrawals amount to 212 cubic metres per person per year and consumption averaged 126 cubic metres per person per year.[10] This translates to withdrawals of 580 l/c/d and consumption of 345 l/c/d. Higher use in southern Alberta is expected because of higher average temperatures, lower precipitation, a much greater reliance on surface water, and more commercial and industrial uses being served through municipal systems. According to Table 3.7, residents of the BRB are withdrawing 30 per cent less water than residents of the SSRB and are consuming 78 per cent less water.

[10] Hydroconsult and Canadian Resrouce Economics Ltd. (2002). *South Saskatchewan River Basin Non-Irrigation Water Use Forecasts.* Prepared for Alberta Environment.

3.2 *Future Conditions*

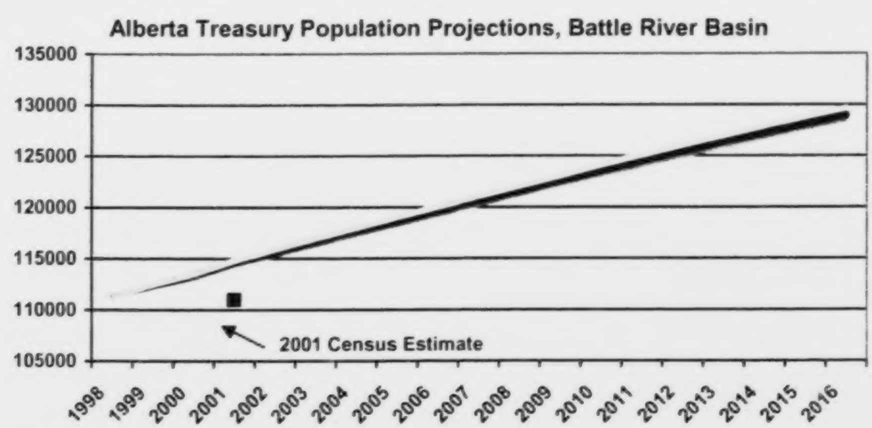
3.2.1 Population Projections

In the 1985 assessment of water use in the BRB, the population of the basin was determined to be about 98,000 and about half (50.3 per cent) resided in one of the 11 communities with a population of 1000 or more. That study noted that while the population of the basin increased by about 26 per cent between 1971 and 1983, the corresponding increase for Alberta was 45 per cent. It suggested that reasons for slower regional population growth included the large rural population and out-migration to other parts of the province. The 1985 study, which employed the most recent population forecasts from the Alberta Bureau of Statistics, predicted that, by 2001, the population of the basin would increase to between 118,800 and 120,600. These estimates assumed that the urban population in the basin would increase by 1.22 to 1.34 per cent per year while the rural populations would increase by between 1.03 and 1.09 per cent per year.

Census information for 2001 indicates that population growth in the basin was slower than predicted in 1985. As noted previously, the total population of the Battle River Basin in 2001 was estimated to be 113,730 people, including an estimated 4900 inhabitants of the six Reserves.[11] This is a 16 per cent increase since 1983, and is significantly less than the 21 to 23 per cent increase predicted in 1985. As shown in Figure 2.2, the rural population of the basin has grown very little since 1983 - only by four per cent - while the population of the 11 communities with a population of more than 1000 people in 1983 has increased by more than 17 per cent.[12]

The most recent Alberta Treasury, Statistics population estimates were published in 1999.[13] Estimates were prepared for each Census Division for 1999 to 2016 using information on births, deaths and migration. Population projections for the BRB were developed using this information based on the percentage of each Census Division within the BRB. The resulting population estimates are presented in Figure 3.17.

Figure 3.17



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11 It is not clear from the 1985 study whether the residents of the First Nations Reserves were included in the population estimates and associated estimates of water use.

12 It should be noted that, in 2001, only nine communities had more than 1000 people.

13 Alberta Treasury, Statistics (1999). *Alberta Population Projections by Census Divisions, 1999-2016.*

According to the projections, the population of the BRB is expected to increase by between 0.80 and 0.85 per cent per year over the forecast period. This is equivalent to a 4.1 per cent increase every five years. The projections also suggest that population growth rates would vary from 4.5 per cent over five years in the upper basin, to 4.2 per cent in the middle basin, to 3.9 per cent in the lower basin.

Actual Census data for 2001 suggests that Alberta Treasury's projections are generally optimistic. For example, the Alberta Treasury projections for 2001 were about three per cent greater than indicated by the 2001 Census. In addition, the projections predicted population growth in the middle basin while the Census shows a significant decline between 1996 and 2001. At the same time, the projections significantly underestimated population growth in the upper basin.

Given that Alberta Treasury's population projections do not accurately portray actual changes since 1996, a number of alternate forecasts were developed. Separate forecasts were developed for the upper, middle and lower basins to reflect the different demographic and economic conditions in each part of the BRB. A summary of the population growth rates used in the forecasts is provided in Table 3.8.

Table 3.8

Summary of Five-Year Growth Rates Used to Forecast Population in the BRB

	1996 to 2001 Trend	Alberta Treasury	Base Case	High Growth Case	Low Growth Case
Upper Basin	10.6%	4.3%	5.0%	7.0%	4.0%
Middle Basin	-4.3%	4.0%	-2.0%	0.0%	-3.6%
Lower Basin	1.2%	3.7%	1.5%	2.5%	0.5%
Battle Basin	6.6%	4.2%	3.0%	4.9%	1.9%

For the upper basin, which underwent a major population increase between 1996 and 2001 (see Table 3.1), the Base Case assumes that the population will continue to grow rapidly at five per cent every five years. This rate is consistent with the rate of population growth since 1996 for the upper basin, excluding the Reserves.[14] The High Growth scenario assumes a rate of seven per cent growth over five years while the Low Growth scenario uses a rate of four per cent. In general, the upper basin has the highest overall potential for population growth because, based on the demographic characteristics presented earlier, it is expected to continue to have a relatively young population, will attract a large number of people from other parts of the province and immigrants, will feature the most diverse economy, and have the highest overall incomes.

The long-term prospects for the middle basins are not nearly so positive. The Base Case assumes that the population will continue to decline at a rate of two per cent every five years. This is half the rate of decline observed between 1996 and 2001, and reflects the expectation that, as the actual number of people most likely to leave the region (young individuals and

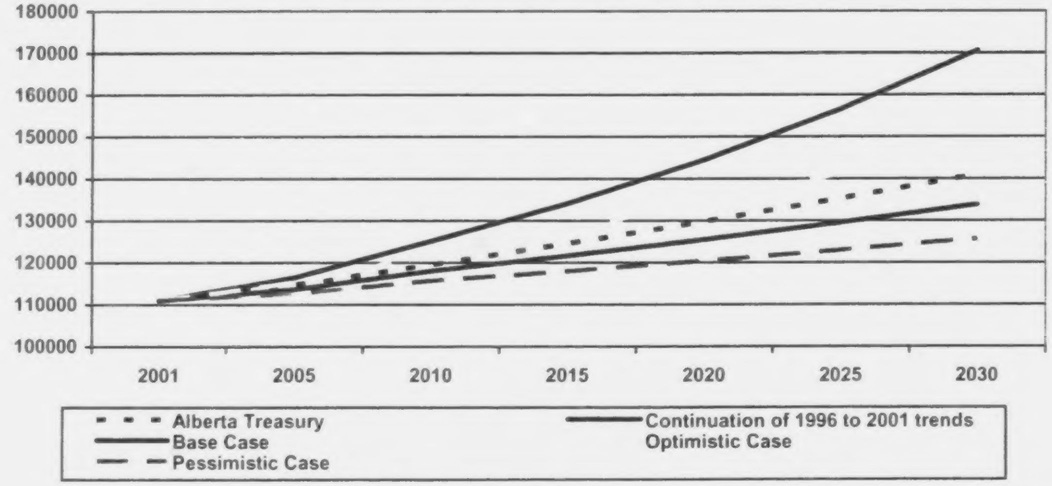
[14] While five per cent appears to be only half the population growth between 1996 and 2001 as reported in Table 3.1, part of the observed historic change in population reflects the high rate of population growth in First Nations population on the Reserves. However, it is unclear whether the changes in Reserve population between 1996 and 2001 reflect actual population increases or differences in the way the population information was collected and reported. If population growth on the Reserves is ignored, the population of the upper basin actually increased by five per cent between 1996 and 2001.

families) diminishes over time, the rate of decline will decrease. The prospects of population growth through immigration remain poor unless there is significant economic diversification that provides new employment outside the agricultural sector. For the High Growth scenario, it is assumed that the existing population remains constant such that births and immigration offset deaths and outmigration. The Low Growth scenario assumes that the population of the middle basin will decline at a rate nearly the same as was observed between 1996 and 2001.

For the lower basin, Census information shows small rural growth and nearly stable urban growth between 1996 and 2001, resulting in a 1.2 per cent population increase. In the future, the population of the lower basin is expected to continue to expand. Part of this increase will be natural; people in the lower basin are younger than the rest of the BRB. However, Camp Wainwright will also be going through a major expansion in the next few years. It is estimated that the Camp will double in the next three years, and this will directly increase the workforce at the base by 600 and increase the population by about 1000. Over the longer term, the Base Case assumes a population growth rate of 1.5 per cent every five years. This is slightly higher than observed since 1996, but reflects the enhanced regional growth that will be generated by expansion at the base. Under the High Growth scenario, the population will increase by 2.5 per cent every five years while, under the Low Growth scenario, a 0.5 per cent increase is predicted.

Figure 3.18

Population Growth Forecasts, Battle River Basin

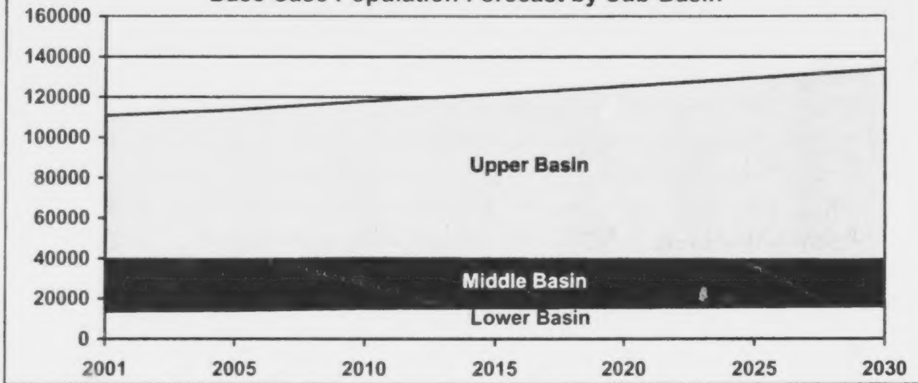


The net result of the population forecasts over the next 25 years for the BRB is demonstrated in Figure 3.18. The figure shows that continuation of the very high growth rates that occurred between 1996 and 2001 would result in the the population of the BRB reaching 170,000 people by 2030. In comparison, the Base Case scenario predicts the population will reach 133,800 by 2030 and this represents a 21 per cent increase from 2001. The High Growth scenario estimates that the population of the BRB will increase by 35 per cent, reaching 148,500 people by 2030. This forecast is slightly higher than the estimates based on the most recent forecasts by Alberta Treasury. Under the Low Growth scenario, the population of the BRB will only increase by 13 per cent to 125,700 over the next 25 years.

As shown in Figure 3.19, the majority of the population growth will occur in the upper basin. While the population of the lower basin in 2030 is predicted to be about 17 per cent higher than current levels, it will still only represent 12 per cent of the overall population of the BRB. The population of the middle basin will shrink steadily throughout the forecast period, dropping from 23 per cent of the BRB population in 2001 to only 17 per cent in 2030. Within the next 25 years, the upper basin will account for 71 per cent of the basin population.

Figure 3.19

Base Case Population Forecast by Sub-Basin



3.2.2 Water Use Projections

In the absence of any significant changes in municipal water management practices, water use will rise in direct proportion to population growth. This means that communities are expected to increase their withdrawals of surface and groundwater as the population grows. In most cases, communities will be able to accommodate additional demand over the next 25 years within the limits of their existing water licences. There will be a number of exceptions to these general trends, however.

First, the Alberta Government passed the *North Red Deer Water Authorization Act* in December of 2002. This allows treated water from the City of Red Deer, which is in the South Saskatchewan River Basin (SSRB), to be piped to Lacombe, Ponoka and parts of the Samson Reserves, which are all located in the North Saskatchewan River Basin.[15] This means that at least 2,016 dam^3 of existing groundwater withdrawals in the upper basin will be displaced by imported surface water starting in 2005 or 2006. Surface water in the BRB will not be affected, however, because the amounts of treated wastewater being returned to the BRB will not change.

Second, in May 2005 the Alberta Government passed the *Stettler Regional Water Authorization Act*, which allows up to 2,941 dam^3 to be diverted from the SSRB for various communities including the Village of Donalda, the Hamlet of Red Willow and some parts of the County of Stettler located in the BRB. The effect of this legislation will be to reduce withdrawals of

[15] According to the *Water Act*, inter-basins transfers of water are not allowed unless authorized by a special Act of the Legislature.

groundwater in the BRB by another 300 to 400 dam^3 per year although returns of treated wastewater being returned to the BRB will also not change.

Third, population growth in some communities will evetually exceed the limits of existing allocations, thereby triggering demands for additional licences and withdrawals. These communities include Camrose which, based on average annual demands, will exceed its licence by 2030 under the High Growth scenario or by 2035 under the Base Case. Wetaskiwin will also exceed its licence by 2025 under the Base Case and 2020 under the High Growth scenario. It is expected that, under the Base Case, other communities in the upper basin, including Bawlf, Ferintosh and New Norway will also require additional allocations. Under the High Growth scenario, these communities plus Hay Lakes, Edberg and Rosalind will all require additional allocations. Based on the projected population decline in the middle basin or, at best, no change, none of the communities will need additional allocations. In the lower basin, only Chauvin will require additional allocations of groundwater within the next 25 years, and this could be required as soon as 2020 under the High Growth scenario. Actual requests for additional allocations will likely occur sooner than stated, however, because communities will likely seek additional water in advance of future population growth in order to address peak demand.

Fourth, rates of water use could decline over time as communities implement water conservation and other initiatives designed to improve water use efficiency. One of the long-term strategies of the *Water for Life* strategy is that "The overall efficiency and productivity of water use in Alberta has improved by 30 per cent from 2005 levels by 2015 (firm targets to be determined by the Provincial Water Advisory Council." Section 9 of this report contains a general discussion of the potential impacts of municipal water conservation programs and changes in water pricing practices for the BRB. Section 8 considers the potential impacts of known possible options for the development of regional water supply systems.

Using the population forecast in Figure 3.19 and the water use assumptions noted above, the resulting estimate of water use is provided in Table 3.20. This represents the amount of water either consumed or lost, and would be about 80 per cent of the water actually withdrawn for municipal and residential purposes.

Figure 3.20

Muncipal and Residential Water Use Forecast: Base Case

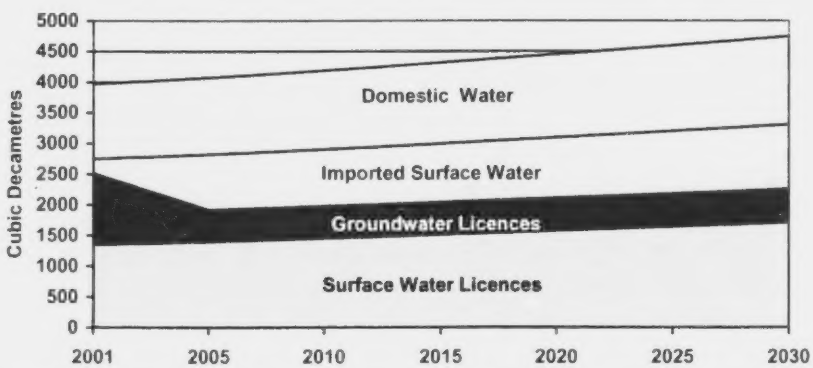
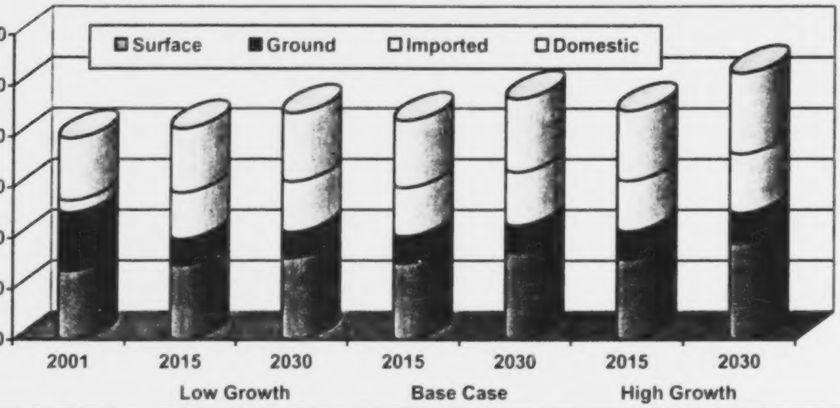


Figure 3.20 shows a major shift in 2005 from groundwater to imported water, and this is due to Ponoka and Lacombe switching to treated water from the City of Red Deer in 2005. Overall, the forecasts indicate that surface water consumption will increase by 12 per cent by 2015 and 26 per cent by 2030, while groundwater use will drop. Figure 3.21 shows the water use forecasts for 2015 and 2030 for each of the population forecasts. Although the volumes of water used differ among the scenarios, the overall pattern of surface and groundwater use is generally the same.

Figure 3.21

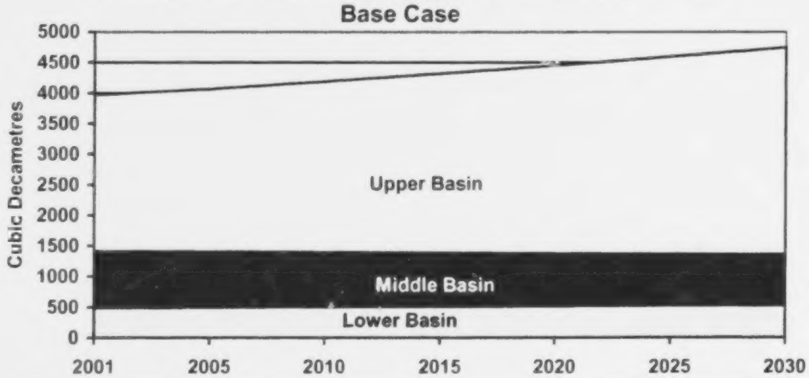
Municipal and Residential Water Use Forecasts: All Scenarios



Forecasts of water use for each of the three BRB sub-basins are provided in Figure 3.22. The figure shows that nearly all of the increased use of water for municipal and residential purposes will occur in the upper basin. While there will also be some increased demand in the lower basin, water use in the middle basin is expected to decline. This matches the population forecasts provided as Figure 3.19.

Figure 3.22

Muncipal and Residential Water Use Forecast by Basin: Base Case



3.3 Summary

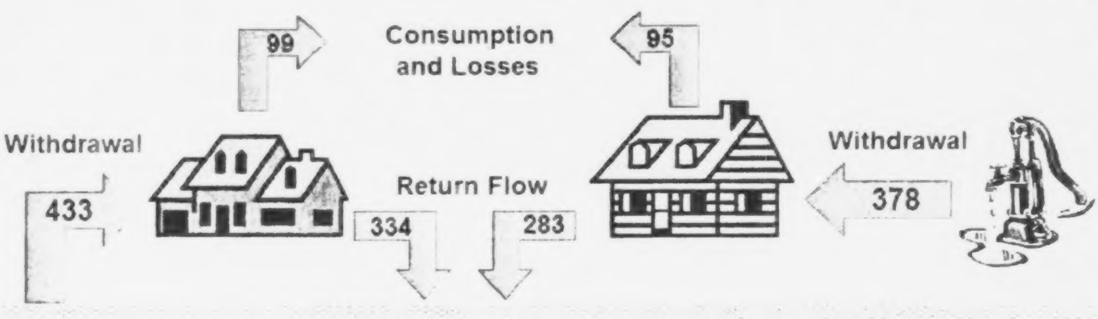
Overall, water allocated for municipal and residential purposes accounts for 11 per cent of all water licences and registrations issued for the BRB. Allocations for municipal and residential purposes represent only six per cent of surface water allocations but 35 per cent of groundwater allocations. The major municipalities that rely on surface water include Camrose, Wetaskiwin, Castor and Wainwright, and most surface water use for municipal water purpose is in the upper basin. Most of the other communities rely on groundwater. A few communities including Viking, Stettler, Botha and Gadsby, rely on water imports from other basins, and Ponoka and Lacombe are expected to start using treated water from Red Deer in the next year.

Although about 12,679 dam^3 of surface water and 6802 dam^3 of groundwater have been allocated for municipal use, available information suggests that actual withdrawals in 2004 amounted to about 1175 dam^3 of surface water and 965 dam^3 of groundwater. Another 1183 dam^3 of water was imported from other basins. Overall, it appears that only 47 per cent of existing allocations are being used, although about half the communities in the basin are using at least 70 per cent of their allocations. It is estimated that about 43,000 rural residents do not draw water from municipal systems and consume about 1225 dam^3 per year.

On a per capita basis, people using surface water withdraw an average of about 433 litres per day and 334 litres winds up as wastewater, resulting in actual consumption and losses of about 99 litres per day. Thus, only 23 per cent of water withdrawals are actually used. Communities that use groundwater withdraw about 378 litres per person per day and return 283 litres as wastewater, so actual consumption is only 95 litres per person per day. Treated wastewater is released back into surface water bodies in the spring and fall and is available for use by downstream users.

Figure 3.23

Municipal Water Withdrawals, Consumption and Return Flow in the BRB



(Litres per Person per Day)

Based on population forecasts it is predicted that surface water consumption will increase by 12 per cent by 2015 and 26 per cent by 2030, while groundwater use declines because of increased reliance on treated water imported into the basin.

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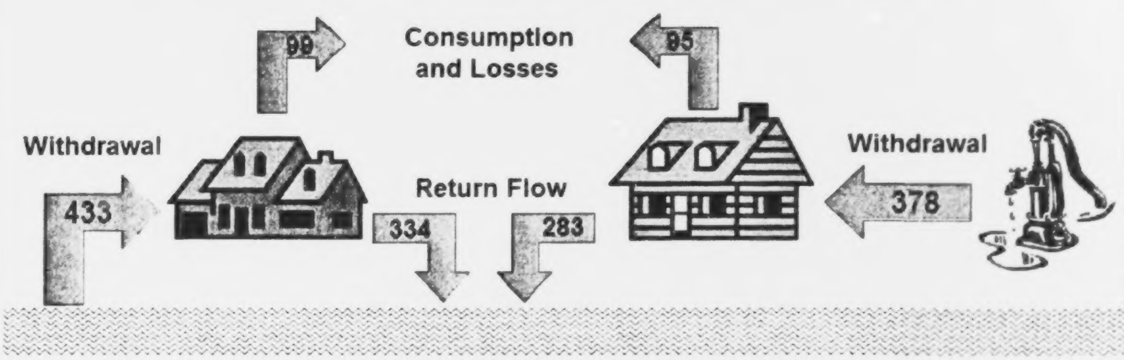

(Litres per Person per Day)

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4 AGRICULTURAL WATER USE

Agriculture is a significant water use in the BRB. Although it accounts for only two per cent of licenced surface water allocations, agriculture is responsible for 23 per cent of licenced surface water use. There are two main types of agricultural water use: stockwatering, including feedlots, and irrigation. Each is assessed below. Farm residential water use was considered in Section 3 as part of the assessment of rural demand and water use.

4.1 *Overview of Agriculture in the Battle River Basin*

Based on estimates derived from the 2001 Census, there were about 6,080 farms in the BRB. As noted in Table 5, nearly half of these (48 per cent) were located in the upper basin, while one third were in the middle basin, and 18 per cent were in the lower basin. These farms covered an area of nearly 5.74 million acres; this is equivalent to about 23,200 km^2 or about 91 per cent of the BRB.

Agricultural land use is fairly consistent throughout the basin. Table 4.1 shows that most land in each part of the basin (between 52 and 58 per cent) is used to raise crops. Less than four per cent of agricultural land is summerfallowed. Most of the remaining land (from 33 to 35 per cent) is pasture. The only significant difference within the basin is that, in the upper basin, about half of the pasture is tame or seeded. In the middle and lower basin land nearly two-thirds of pasture land is natural pasture.

Table 4.1

Use of Agricultural Land in the Battle River Basin, 2001

	Upper Basin		**Middle Basin**		**Lower Basin**		**Battle River Basin**	
	Acres	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Land in Crops	951,092	58.2	1,418,821	54.5	773,876	51.6	3,143,790	54.8
Summerfallow	33,073	2.0	122,596	4.7	67,819	4.5	223,488	3.9
Tame/Seeded Pasture	268,373	16.4	288,220	11.1	184,784	12.3	741,377	12.9
Natural Pasture	271,333	16.6	656,798	25.2	400,952	26.8	1,329,082	23.2
All Other Land	109,771	6.7	117,439	4.5	71,167	4.7	298,377	5.2
Total	1,633,642		2,603,873		1,498,599		5,736,114	

The types of farming activity vary within the BRB. Table 4.2 shows the classification of farms based on the commodity groups that accounted for 51 per cent or more of total gross farm receipts. The table shows that nearly half the farms in the BRB raise cattle (46 per cent) and this percentage is fairly consistent throughout the basin. The highest percentage of cattle farms occurred in the upper basin which also has a much larger number of other livestock farms, including dairy, hog and poultry operations. From a provincial perspective the upper basin accounts for a significant proportion of hens and chickens (9.3 per cent of provincial production), turkeys (13.6 per cent), milk cows (11.1 per cent), bison (7.5 per cent), and deer and elk (9.2 per cent). As noted in Table 5, farms in the upper basin were much smaller (557 acres) than in the rest of the BRB (1303 acres), reflecting the presence of numerous small intensive livestock operations in the upper basin. While farms in the middle and lower basins are much larger, their

capacity to raise cattle is less than in the upper basin because more of the land is natural pasture that can support fewer animals.

Table 4.2

Classification of Farms in the Battle River Basin, 2001

Farm Type (Farms with Gross Receipts >$2500)	Upper Basin	Middle Basin	Lower Basin	Total Basin
Cattle (Beef)	48.1%	43.9%	44.5%	46.0%
Other Livestock	11.1%	4.8%	5.4%	7.9%
Wheat	3.3%	9.3%	6.4%	5.9%
Grain & Oilseeds	17.3%	31.1%	32.0%	24.7%
Field Crops	6.9%	3.9%	4.0%	5.3%
Specialty Crops	13.4%	6.9%	7.7%	10.2%

Nearly 40 per cent of the farms in the middle and lower basins are classified as wheat or grain and oilseed farms while field or specialty crops account for more than half of gross revenues for 11 per cent of farms. Use of cropland in the upper basin is significantly different. Only half as many farms are classified as wheat or grain and oilseed farms (21 per cent) while nearly twice as many (21 per cent) are dependent on field and specialty crops for more than half their revenues. These specialty and field crops include vegetables, potatoes, silage corn and alfalfa.

Within Alberta there has been a trend toward fewer farms operating on a slightly expanding land base. Between 1996 and 2001 the number of Alberta farms decreased by nine per cent while the amount of land being farmed actually increased by 0.2 per cent. In the BRB there has also been a decrease in the number of farms. In 2001 there were about 700 fewer farms, a decrease of 10.3 per cent. Almost half of this decline (320 farms) was in the upper basin while there were 271 fewer farms in the middle basin. In terms of the land area being farmed, there was a 3.1 per cent increase in the lower basin while less land was being farmed in the upper and middle basins. Reductions of 0.5 and 3.1 per cent were reported for the upper and middle basins, respectively, with the net result that the area farmed in the BRB actually dropped by 0.3 per cent between 1996 and 2001.

4.2 Livestock

4.2.1 Existing Conditions

In 2001 more than half of the farms in the BRB (54 per cent) were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 4.3. The table shows that there were more than 1.5 million chickens and turkeys in the BRB, with 81 per cent of these in the upper basin. There were 0.75 million cattle in the BRB, mostly beef cows and calves. This is about 6.5 times the human population of the BRB. About 41 per cent of cattle were in the upper basin, 37 per cent in the middle basin, and 21 per cent in the lower basin. The BRB also had about 0.25 million pigs in 2001, with nearly half (47 per cent) in the upper basin. Populations of other species of livestock, such as sheep, goats, horses, bison, deer and elk, were relatively small in comparison, with a total of only about 71,430 animals.

Table 4.3

Estimated Livestock Populations in the Battle River Basin, 2001

	Upper Basin	Middle Basin	Lower Basin	Total Basin
Hens & Chickens	1,137,117	212,028	69,663	1,418,808
Turkeys	112,237	3,671	1,570	117,479
Total Cattle & Calves	310,356	278,226	160,049	748,631
Total Pigs	117,536	68,219	61,502	247,258
Total Sheep & Lambs	19,224	10,076	5,140	34,439
Horses & Ponies	11,343	5,391	2,728	19,462
Goats	2,329	172	419	2,920
Bison	5,946	1,152	2,794	9,892
Deer & Elk	3,660	388	668	4,716

Within Alberta there has been a trend in livestock farming toward concentration and intensification, with more animals on fewer farms. This trend is also apparent in the BRB. Table 4.4 compares livestock populations in the BRB between 1996 and 2001. For most livestock species the table shows an increase in population but a reduction in the number of farms raising these species, resulting in more animals per farm in 2001. For example, in 2001 there were 209 fewer farms raising pigs, but the average number of pigs per farm more than doubled. This resulted in a 25 per cent increase in the number of pigs in the BRB. One noticeable exception is dairy operations where the total number of milk cows actually declined by 12 per cent. The number of farms raising sheep, goats, bison, deer and elk increased from 1996 to 2001 and, for most of these species, the number of animals per farm also increased. Figure 4.1 shows the trends in farms and animal populations for hens and chickens, cattle and calves, pigs, and bison.

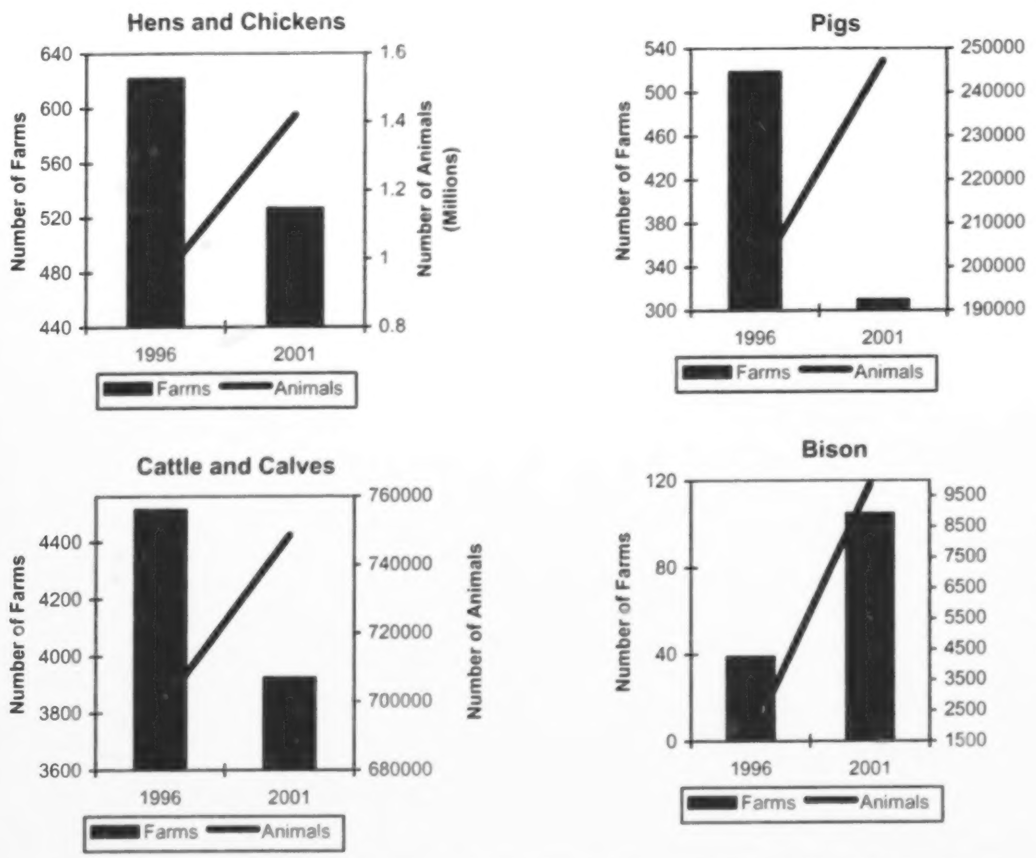
Table 4.4

Change in Livestock Populations in the Battle River Basin, 1996 to 2001

	Number of Animals		Number of Farms		Animals per Farm	
	1996	2001	1996	2001	1996	2001
Hens & Chickens	924,959	1,418,808	622	527	1,486	2,694
Turkeys	92,606	117,479	145	106	640	1,107
Total Cattle & Calves	698,026	748,631	4,514	3,925	155	191
Milk cows	14,657	12,918	383	199	38	65
Beef cows	256,724	284,969	3,965	3,535	65	81
Calves - under 1 yr.	230,690	261,624	4,044	3,642	57	72
Total Pigs	197,226	247,258	519	310	380	797
Total Sheep & Lambs	18,231	34,439	303	349	60	99
Horses & Ponies	16,358	19,462	2,029	1,829	8	11
Goats	2,945	2,920	202	377	15	8
Bison	1,574	9,892	39	105	41	95
Deer & Elk	1,618	4,716	32	70	50	67

Figure 4.1

Changes in Livestock farms and Populations in the Battle River Basin, 1996 to 2001



Farmers have been able use water for livestock purposes in four different ways. First, very small operations requiring less than 1,250 m^3 per year for domestic, livestock and crop purposes combined are entitled to use water for household purposes without having to obtain a licence or registration. The number of such operations in the BRB is not known. Second, the *Water Act* allowed farmers to obtain a registration for traditional agricultural use where the priority of the registration dated back to recorded first use. Registrations allow farmers to use up to 6,250 m^3 of water per year. To acquire a registration, farmers had to submit an application prior to December 31, 2001. For the BRB, some 6,645 registrations representing a total allocation of 1,966 dam^3 were issued for surface water. Another 4,860 registrations were issued for groundwater and allow withdrawals and consumption of 4,950 dam^3. Third, for new farms or existing operations requiring more water than authorized by a registration, a water licence must be obtained. These licences are issued either for stockwatering or for feedlots and the priority of water use is based on the date the completed application was received. As of November 2004 about 1,577 licences had been issued to allow diversion of up to 7,947 dam^3 of groundwater and surface water. Fourth, operations that are located adjacent to surface water or above groundwater and have used water for livestock purposes prior to 1999 can use up to 6,250 m^3 of water per year without having to acquire a licence or registration, but such use has no priority. These are termed "exempted agricultural users" and the use of water by such users in the BRB is unknown.

A historical perspective on water used for livestock is provided in Figure 4.2. The figure shows that some registrations were issued with priority dates in the 1890s while licences for stockwatering began to be issued prior to 1920. Allocations for stockwatering have risen steadily since the 1900s, with substantial increases occurring since 1960s. Prior to 1980 most allocations were associated with groundwater registrations and licences and registrations for surface water. During the 1970s and 1980s most new stockwater licences were issued for groundwater. Issuing licences for feedlots commenced in the 1990s and currently account for about five per cent of water allocations for livestock. Since 2000 only a few new licences have been issued for groundwater or surface water and no registrations were issued with priority dates after 1999.

Figure 4.2

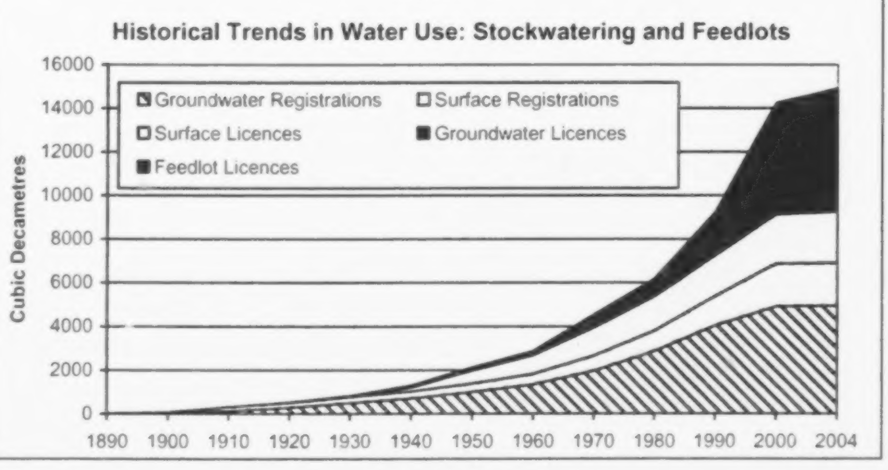


Table 4.5

Summary of Water Licences and Registrations Issued for Livestock Watering in the Battle River Basin

		Licences			Registrations			TOTAL	
		Number	**Diversions**	**Water Use**	**Number**	**Diversions**	**Water Use**	**Diversions**	**Water Use**
	Groundwater	670	2,421	2,421	2,465	2,765	2,765	5,186	5,186
Upper	Surface	85	271	271	1,864	716	716	987	987
Basin	Feedlots (ground)	28	170	170				170	170
	Feedlots (surface)	0	0	0				0	0
	Total	783	2,862	2,862	4,329	3,481	3,481	6,343	6,343
	Groundwater	296	1,537	1,537	1,597	1,394	1,394	2,931	2,931
Middle	Surface	278	1,858	1,858	3,230	864	864	2,722	2,722
Basin	Feedlots (ground)	10	250	250				250	250
	Feedlots (surface)	3	142	142				142	142
	Total	587	3,787	3,787	4,827	2,258	2,258	6,045	6,045
	Groundwater	140	894	894	798	791	791	1,685	1,685
Lower	Surface	47	206	206	1,551	375	375	581	581
Basin	Feedlots (ground)	20	198	198				198	198
	Feedlots (surface)	0	0	0				0	0
	Total	207	1,298	1,298	2,349	1,166	1,166	2,464	2,464
	Groundwater	1,106	4,852	4,852	4,860	4,950	4,950	9,802	9,802
Battle	Surface	410	2,335	2,335	6,645	1,955	1,955	4,290	4,290
Basin	Feedlots (ground)	58	618	618				618	618
	Feedlots (surface)	3	142	142				142	142
	Total	**1,577**	**7,947**	**7,947**	**11,505**	**6,905**	**6,905**	**14,852**	**14,852**

Table 4.5 and Figure 4.3 summarize the water licences and registrations issued for stockwatering and feedlots according to the water source and sub-basin. They show that only 17 per cent of licenced water use by livestock can occur in the lower basin. The balance of livestock water use is nearly equally split between the upper and middle basins. The data also show that most water allocated for livestock is groundwater, which accounts for 66 per cent of allowable diversions. Groundwater use is most significant in the upper basin where it accounts for 82 per cent of livestock use, with slightly more than half being registrations. Groundwater use also accounts for 68 per cent of livestock water use in the lower basin. Use of surface water for livestock is most important in the middle basin where it accounts for 52 per cent of total allocations and about 60 per cent of this is allocated by way of licences. Licenced water use for feedlots is concentrated in the middle basin. Within the BRB, 58 of the 61 feedlot licences are groundwater and account for 81 per cent of feedlot allocations. All water allocated by licenses and registrations is considered to be used, either through consumption by animals or as losses.

Figure 4.3

Licenced Allocations and Water Use by Livestock by Sub-Basin

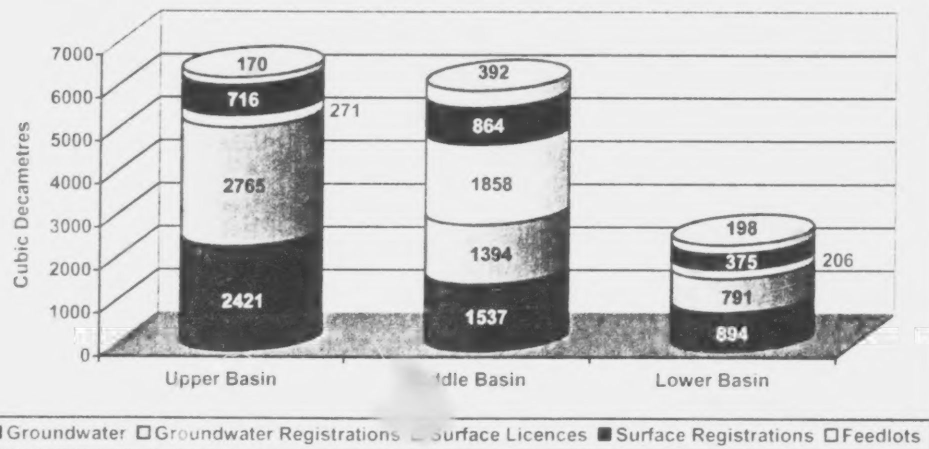


Table 4.5 shows that, between licences and registrations, about 14,852 dam^3 of water has been allocated for livestock use in the BRB. While there is no information to indicate the extent to which water allocations are actually used in the BRB, it appears that the allocation exceeds actual livestock water use. Based on livestock populations for the BRB in 2001, the total water required for livestock was estimated to be 9,710 dam^3, or about 65 per cent of the licenced allocation.[16] The calculations for this estimate are provided in Table 4.6 which shows livestock populations in the BRB and daily water requirements for various livestock species as provided by Alberta Environment in its "Guide to Calculate Quantities for Water for Raising Animals".[17] In terms of water requirements by species, cattle accounted for 84 per cent of the total, eight per

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[16] This approach to estimating water use for stockwatering was employed in the 1986 Battle River Basin water use study undertaken by Stanley Associates in 1985.

[17] http://www3.gov.ab.ca/env/water/Legislation/Approvals/Licences/CalculationChart.doc

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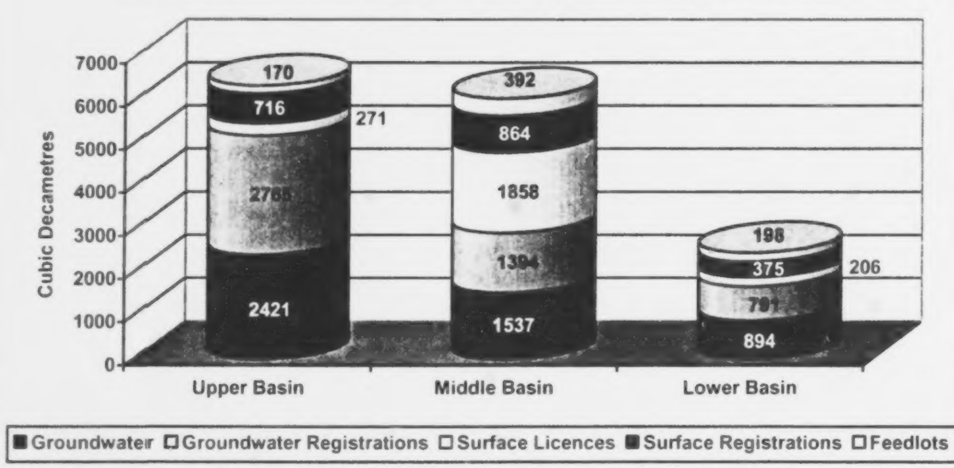

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[17] http: www3.gov.ab.ca env water Legislation Approvals_Licences CalculationChart.doc

cent was required by pigs, poultry only required one per cent, and all other species accounted for the remaining seven per cent.

Table 4.6

Estimated Livestock Water Requirements for 2001[18]

	Animal Population	Per Animal	Upper Basin	Middle Basin	Lower Basin	Total Basin
			Water Requirements			
		Gallons/day	dam^3			
Hens & Chickens	1,418,808	0.045	84.9	15.8	5.2	105.9
Turkeys	117,479	0.15	27.9	0.9	0.4	29.2
Bulls - 1 yr & older	15,633	9	84.5	90.0	58.8	233.3
Milk cows	12,918	30	464.9	69.7	108.1	642.7
Beef cows	284,969	9	1785.7	1532.7	934.8	4253.2
Heifers - 1 yr & older	106,902	6	439.1	393.9	230.7	1063.7
Steers - 1 yr & older	64,304	6	254.7	281.2	103.9	639.8
Calves - under 1 yr.	261,624	3	527.2	487.4	287.0	1301.6
Boars	949	6.5	4.9	3.5	1.9	10.2
Sows & Gilts - Breeding	24,776	6.5	137.0	65.1	65.0	267.1
Nursing & Weaner pigs	221,535	0.5	86.5	51.3	45.9	183.7
Grower & Finishing Pigs	136,914	1.5	160.0	101.3	79.2	340.6
Total Sheep & Lambs	34,439	2	63.8	33.4	17.0	114.2
Horses & Ponies	19,462	10	188.1	89.4	45.2	322.7
Goats	2,920	2	7.7	0.6	1.4	9.7
Bison	9,892	10	98.6	19.1	46.3	164.0
Deer & Elk	4,716	3.5	21.2	2.3	3.9	27.4
TOTAL			**4,437**	**3,238**	**2,035**	**9,710**
			46%	**33%**	**21%**	**100%**

Based on the distribution of livestock populations throughout the basin, Table 4.6 suggests that about 46 per cent of livestock water requirements are in the upper basin, 33 per cent in the middle basin, and 21 per cent in the lower basin. This pattern is similar to the licence and registration information (Table 4.5). Both show that livestock water use is greatest in the upper basin and smallest in the lower basin. However, the consumption data based on animal populations is a bit higher for the upper basin (three percent) and the lower basin (four per cent), but eight per cent lower for the middle basin.

While the estimated actual consumption based on livestock populations (9,710 dam^3) appears to be significantly less than the amount of water allocated for stockwatering (14,852 dam^3), the data in Table 4.6 do not include an allowance for the evaporative and seepage losses associated with storing water for stock water use. Typically, licenced consumption accounts for only 35 per cent of surface water allocated for stockwater use while losses account for 65 per cent. If two-thirds of stockwater consumption comes from groundwater (no losses) and the balance comes from surface water with 65 per cent losses, a total allocation of 15,840 dam^3 would be required to support the animal populations in Table 4.6. This is only slightly larger than the stockwater

[18] Water requirements for various species provided by Alberta Environment at http://www3.gov.ab.ca/env/water/Legislation/Approvals_Licences/CalculationChart.doc.

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allocation. Consequently, it is assumed that actual water use is equivalent to the amount of water allocated for livestock, including feedlots. The natural flow estimates for the Battle River also assumed that livestock consumption was equivalent to 100 per cent of the allocation, and that surface water withdrawals occurred during April when dugouts and storage dams were filled and flows were at their peak.

4.2.2 Future Conditions

The key factor affecting future livestock water demand is changes in cattle populations in the basin. As noted above, cattle account for about 84 per cent of livestock water demands in the BRB, so changes in the populations of other livestock species will have a minimal overall impact on future water demand.

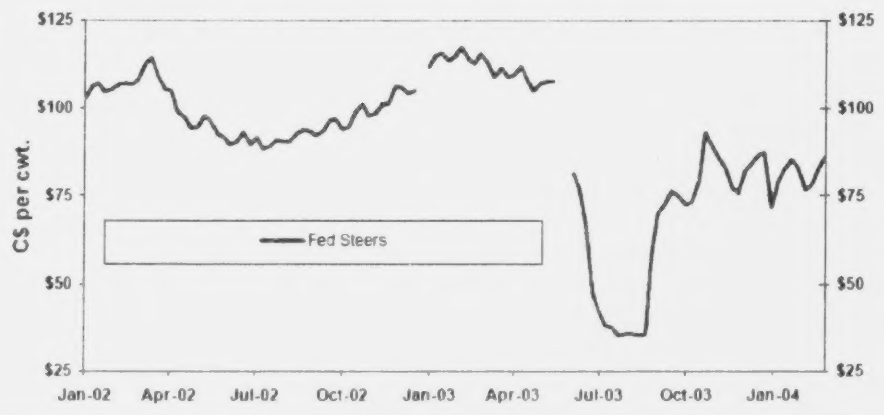
Any prediction of future cattle populations in the BRB at this point in time is highly speculative given the recent uncertainty in world and North American cattle markets due to the discovery of one case of Bovine Spongiform Encephalopathy (BSE) in Alberta in May 2003. An investigation into the effects of BSE on cattle pricing made the following observations:

> The BSE crisis created a situation where fed cattle prices were under pressure as a result of three factors: a lower overall demand for beef products in export markets; an excess supply of domestically produced beef; and higher costs associated with the production of beef due to new regulatory and testing standards.[19]

As shown in Figure 4.4, the price of feeder cattle dropped significantly as foreign borders were closed to exports of Canadian cattle and processed beef in May of 2003. In August 2003 the U.S. government announced that it would accept cuts of Canadian beef from cattle under 30 months of age and this caused prices to rebound somewhat. However, current prices are still only about 75 to 80 per cent of what they were in 2002

Figure 4.4

Alberta Cattle Markets – Weekly Average Steer Prices

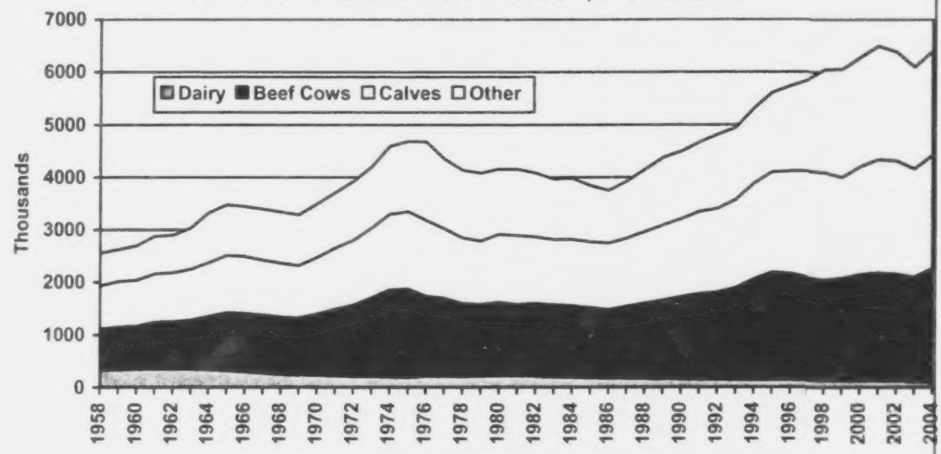


[19] Alberta Agriculture, Food and Rural Development (2004). *Review of Pricing in the Beef Industry*. March, 2004. Page 2.

As a result of this price uncertainty and trade restrictions, cattle sales have dropped and inventories have increased with the result that there are concerns that there could be a significant over supply of slaughter weight cattle in Canada. The effects of these lower prices and reduced sales volumes are not reflected in the agricultural statistics presented in Table 4.4, which are based primarily on the 2001 Census of Agriculture. A more current description of cattle populations in Alberta is provided in Figure 4.5. This figure shows that, between 1986 and 2002, the number of cattle on Alberta farms grew steadily from about 3.75 million to 6.50 million animals. This represents about a 75 per cent increase, or an annual increase of 3.7 per cent. There was a significant decrease (six per cent) in cattle numbers in 2003 but populations have started to increase because the US is not accepting any live animals from Canada and Alberta farmers are waiting for prices to rebound.

Figure 4.5

Cattle and Calves on Alberta Farms, 1958 to 2004



A second factor affecting livestock expansion in Alberta is recent changes in regulation of the livestock industry. Effective January 1, 2002, amendments to the *Agricultural Operation Practices Act (AOPA)* require that farmers wanting to develop new livestock operations or expand their annual populations above a certain size threshold must first obtain permission from the Natural Resources Conservation Board (NRCB). To obtain this permission, farmers must submit an application that demonstrates how their operations would meet the legislated requirements for manure storage and management. Farmers must also demonstrate that they have or can obtain the rights to sufficient water to support livestock. The NRCB must deny any applications that fail to meet the requirements for manure management, setbacks from neighbours, access to water, or any of the other requirements of the legislation. For the cattle and dairy operations, the animal population thresholds are as follows:

Type of Livestock	Registration Required	Approval Required
Beef cows/finishers (900+ lbs)	150-349	350+
Beef Feeders (<900 lbs)	200-499	500+
Dairy (milking cows including replacements and dries)	50-199	200+

Similar thresholds are established for swine and poultry operations. While the application requirements to acquire a Registration or an Approval are essentially the same, the process for obtaining Approvals requires consideration of a broader range of issues and provides opportunities for neighbours to submit their views regarding how they would be affected by the proposed development. Under *AOPA*, any farmers wanting to change or modify an existing manure storage facility (with no change in livestock numbers) must first obtain an Authorization from the NRCB.

In the three years that *AOPA* has been in effect, there have been numerous applications for Approvals, Registration and Authorizations from livestock operations in the BRB. Information from the NRCB indicates that, as of June 30, 2004, there had been 370 applications from farmers throughout the province. Data also indicate that 79 of these applications (21 per cent of the total) were from operations in the BRB. The status of these applications is as follows:

Type of Application	Number	Withdrawn	Approved	Denied	In Progress
Approval	22	5	9	2	6
Registrations	29	8	13	5	3
Authorizations	28	5	22	1	0
TOTAL	79	18	44	8	9

In reviewing this information it should be noted that, because of poor market conditions for cattle and hogs during this three-year period, many applicants chose to withdraw their applications or failed to provide the necessary information within the time period specified, resulting in a denial.

It should be noted that the vast majority of applications (71 per cent) in the BRB were from operations in the upper basin. Of the 15 Approvals and Registrations issued in the upper basin, six were for hog operations, six were for dairy operations and three were for poultry. The middle basin accounted for 20 per cent of applications and three Approvals and Registrations were issued. Two were for hog operations and one was for a dairy expansion. Only nine per cent of applications came from the lower basin and four Approvals were issued for hog operations. No Approvals or Registrations were issued for new or expanding beef cattle operations, and this probably reflects the depressed state of the cattle industry for the past three years.

With the cattle industry expected to stabilize and then expand in the near future, much of the expansion would be subject to the requirements of *AOPA*. An assessment of average cattle populations on farms in the BRB indicates that many existing operations are already above the size thresholds so that further expansion would require a Registration, or an Approval where major expansions are considered. At the time of the 2001 Census, cattle farms in the upper basin had an average of 169 cattle and calves. This number increased to 207 in the middle basin and 217 in the lower basin. A study conducted by the NRCB also determined that, as of 2001, 24 of 212 dairy operations in the BRB larger than the Approval threshold and 108 were larger than the Registration threshold.[20] It also found that 107 of these larger operations were in the upper basin. Thus, the potential for future expansion of the cattle industry in the BRB will depend on whether proposed development can meet the manure management and other requirements set out in *AOPA*.

[20] Natural Resources Conservation Board (2003). *Confined Feeding Operations in Alberta, 2001: A Statistical Assessment.*

A study undertaken by AAFRD in the late 1990s provides some insights regarding the potential for expansion of the beef industry in the BRB.[21] With respect to the possible development of feedlots, AAFRD identified five criteria for evaluating the potential for expansion:

1. **Manure odour and population densities** - Manure odours were considered the most limiting factor in selecting sites for new feedlots, in that feedlots can only be located beyond specific distances from neighbouring residences in order to minimize odour impacts.[22] Thus, feedlot development is more likely in areas with low population densities.

2. **Local silage supplies** – Adequate quantities of silage can only be economically produced in some parts of Alberta. AAFRD identified areas where sufficient silage could be grown within six miles of the feedlot so that hauling would be economical.

3. **Water supply** – The availability of ground water was the second most important factor in selecting potential feedlot sites. It is estimated that a 5,000 head backgrounding operation would require 50 dam^3 of water per year while a 20,000 head finishing operation would require 300 dam^3. Consequently the study identified areas where sufficient water was available and could reliably be supplied using more than one source (four wells). Surface water sources must be permanently flowing to provide a reliable water supply for feedlots.

4. **Landscape characteristics** – The preferred locations for feedlots are areas with well developed natural drainage to ensure that pens stay dry and drain completely. Suitable areas were identified using slope information from the Soil Landscapes of Canada.

5. **Land for manure spreading** – Extensive lands are required for spreading of manure and are similar to land requirements for barley silage. Land requirements for manure spreading are now identified in the *Agricultural Operation Practices Act* but AAFRD determined that about 5.5 sections are required for a 20,000-head feedlot.

Using these selection criteria, AAFRD was able to identify townships where development of a 5,000 head backgrounding operation or a 20,000 head finishing feedlot was possible.

Figure 4.6 shows which townships in the BRB Alberta met two or more of the criteria for a 5,000 backgrounding operation. The figure shows that, while 85 per cent of the townships met two or more criteria, only 19 per cent met the criteria for groundwater availability, density and odour, silage and landscape. In addition, Figure 4.6 shows that that groundwater is a key limiting factor. Only 38 per cent of townships were determined to have sufficient groundwater resources for a 5,000 head backgrounding operation, and these were primarily in the middle and lower portions of the BRB.

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[21] Alberta Agriculture, Food and Rural Development. (1977) *Resources for Beef Industry Expansion in Alberta.*
[22] In the 1990s these distances were contained in a Code of Practice but setback distances are now specified in the regulations for the *Agricultural Operation Practices Act.*

Figure 4.6

Townships in the BRB Meeting Criteria for a 5,000 Head Backgrounding Operation

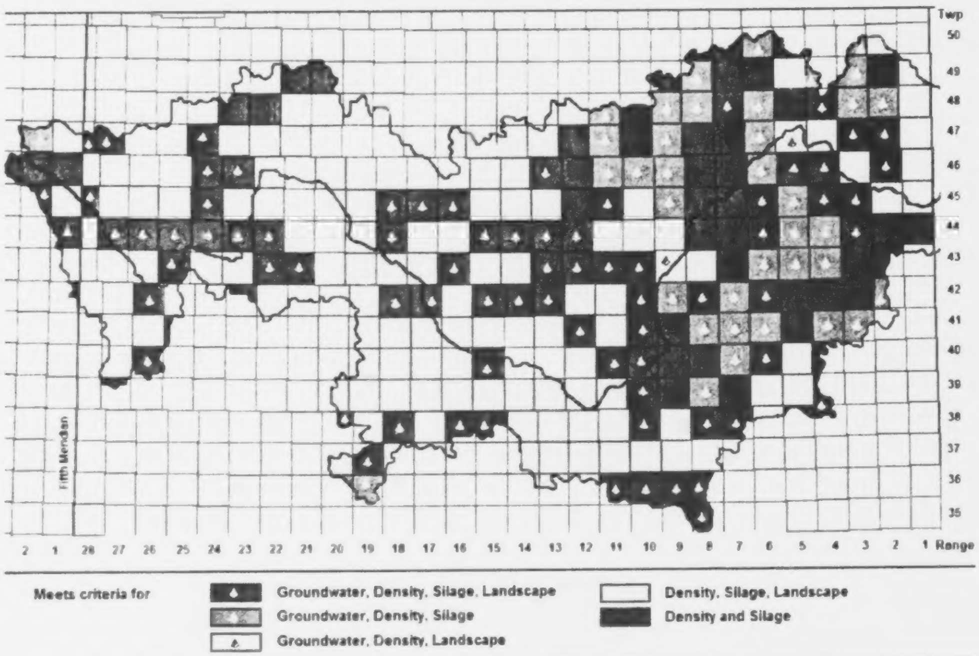


Figure 4.7

Townships in the BRB Meeting Criteria for a 20,000 Head Finishing Operation

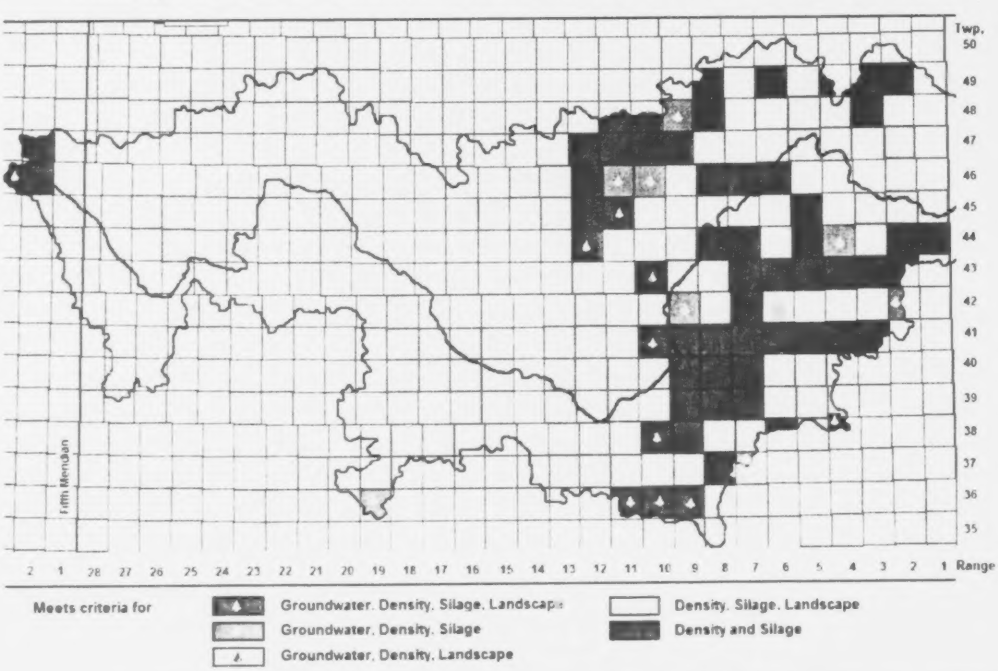


Figure 4.7 presents the corresponding analysis for a 20,000 head finishing operation. It was determined that only 45 per cent of townships were able to meet two or more of the criteria for these larger operations. Furthermore, only three per cent of townships met four of the criteria; these were almost entirely in the middle basin. In terms of water availability, only six per cent of townships were considered to have sufficient supplies, mostly in the middle basin.

Based on AAFRD's assessment, it would appear that lack of adequate water will likely limit significant livestock expansion in the upper basin. And, while there is capacity for expansion in the middle and lower basins, this expansion will more likely consist of 5,000-head operations rather than the 20,000-head operations currently found in southern Alberta.

Given the new regulatory regime and the assessment of capability of the basin to support cattle expansion in the basin, it is expected that livestock expansion will occur at a higher rate in the middle and lower parts of the basin. As a Base Case for projecting future livestock populations and stockwater requirements, it is assumed that the rate of expansion in the middle and lower basin will resume at a rate of about 1.5 per cent per year over the next 25 years. However, expansion in the upper portion of the basin is expected to occur at only half this rate (0.8 per cent per year). Within the BRB, the average rate of growth in water requirements will be about 1.2 per cent per year. The resulting estimates of livestock water requirements are provided in Table 4.7 and Figures 4.8 and 4.9.

Table 4.7

Future Livestock Water Requirements: Base Case

		2004	2010	2015	2020	2025	2030
Upper basin	Groundwater	5,356	5,618	5,847	6,084	6,332	6,589
	Surface	987	1,035	1,077	1,121	1,167	1,214
	Total	6,343	6,654	6,924	7,205	7,498	7,803
Middle Basin	Groundwater	3,181	3,478	3,747	4,037	4,349	4,685
	Surface	2,864	3,132	3,374	3,634	3,915	4,218
	Total	6,045	6,610	7,121	7,671	8,264	8,903
Lower Basin	Groundwater	1,883	2,059	2,218	2,389	2,574	2,773
	Surface	581	635	684	737	794	856
	Total	2,464	2,694	2,902	3,127	3,368	3,629
Battle Basin	Groundwater	10,420	11,155	11,812	12,510	13,254	14,047
	Surface	4,432	4,802	5,135	5,493	5,876	6,288
	Total	**14,852**	**15,958**	**16,947**	**18,003**	**19,131**	**20,334**

A Low Growth scenario would see livestock populations increasing by only 1.0 per cent per year in the middle and lower basins and 0.5 per cent in the upper basin, while a High Growth scenario would see annual increases of 2.0 per cent in the middle and lower basins and 1.0 per cent in the upper basin. Under these alternative assumptions, estimated stockwater requirements would be ±4.5 per cent by 2015 and ± 10 per cent by 2030.

Figure 4.8

Projected Stockwater Use, by Sub-Basin, Battle River Basin

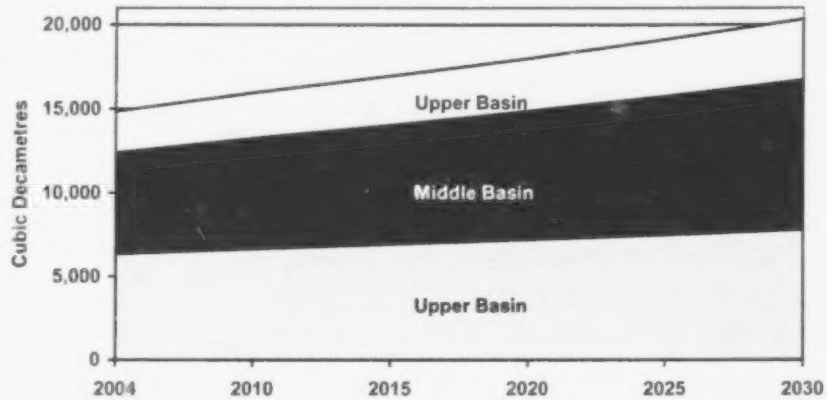
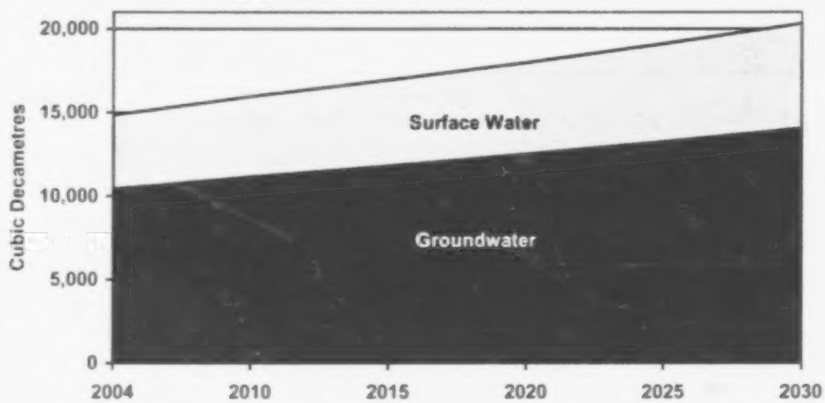


Figure 4.9

Projected Stockwater Use, by Source, Battle River Basin



4.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. Unlike southern Alberta, where most irrigation is done by farmers who obtain their water from an irrigation district, farmers in the BRB are private irrigators who have their own water licences and divert water using their own pumps and water distribution equipment.

4.3.1 Existing Conditions

As of November 2004 there were 176 surface water licences that allocated 12,197 dam^3 of water to irrigate 4,602 hectares (ha). These licences had been issued to about 150 different water users. A summary of the water licence information is provided in Table 4.8 and Figure 4.9. They show

that about two-thirds of the licences (67 per cent) were issued in the middle basin, which account for 60 per cent of the water allocation and 63 per cent of irrigated acres. In comparison, about 20 per cent of licences representing 18 per cent of irrigation acres were issued in the upper basin, while the lower basin has 13 per cent of irrigation licences and 18 per cent of irrigated acres. Most licences were issued to private individuals for irrigation purposes, although there were a few licences for greenhouses, sod farming, and orchards. Other irrigation licences were issued to Hutterite colonies, Ducks Unlimited, and municipal governments.

Table 4.8

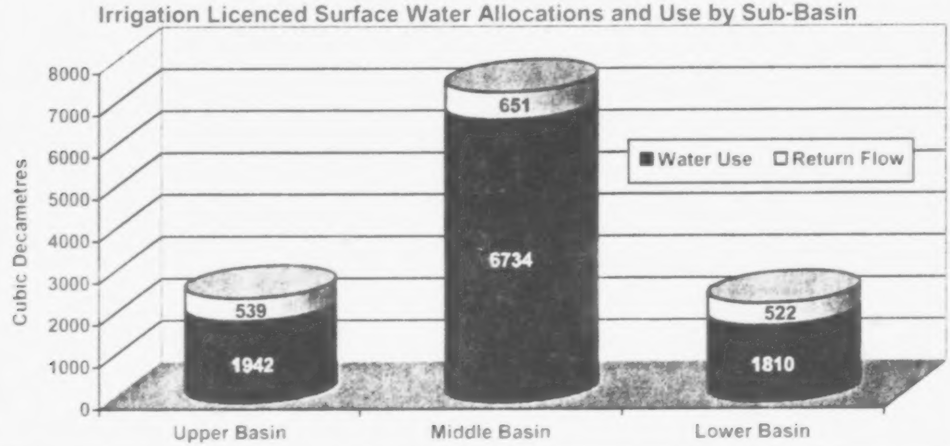
Summary of Surface Water Licences Issued for Irrigation in the Battle River Basin

	Licences	Allocation	Water Use	Return	Irrigation
			dam^3		Hectares
Upper Basin	35	2,481	1,942	539	837
Middle Basin	118	7,385	6,734	651	2,913
Lower Basin	23	2,331	1,810	522	852
Battle Basin	**176**	**12,197**	**10,485**	**1,712**	**4,602**

Table 4.8 and Figure 4.10 also show that not all of the water allocated for irrigation can be used. Overall, about 10 per cent of water is to be returned to surface sources in the basin, although this percentage is higher in the upper and lower basins (22 per cent) than in the middle basin (nine per cent).

Figure 4.10

Irrigation Licenced Surface Water Allocations and Use by Sub-Basin



The water rights information shows that 27 of these irrigation licences were issued to Ducks Unlimited for the Ribstone Creek Complex, a series of multiple use projects where land is flooded in the spring to provide waterfowl habitat and improved forage production for livestock. These 27 licences allow withdrawals of 3,853 dam^3 and consumption of 3,071 dam^3 on 1502 ha; this represents about 33 per cent of irrigation in the BRB. This backflood irrigation is almost equally split between the middle and lower basins. On average, the licences issued for Ducks

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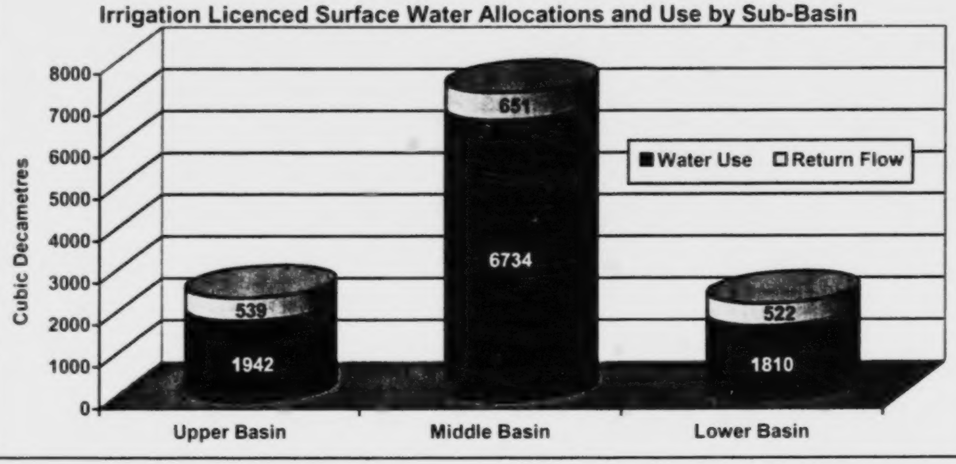


The water rights information shows that 27 of these irrigation licences were issued to Ducks Unlimited for the Ribstone Creek Complex, a series of multiple use projects where land is flooded in the spring to provide waterfowl habitat and improved forage production for livestock. These 27 licences allow withdrawals of 3,853 dam^3 and consumption of 3,071 dam^3 on 1502 ha; this represents about 33 per cent of irrigation in the BRB. This backflood irrigation is almost equally split between the middle and lower basins. On average, the licences issued for Ducks

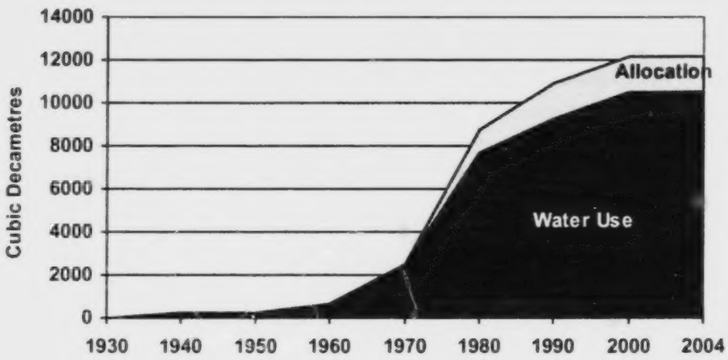
Unlimited projects allow withdrawals of 143 dam^3 for 55.6 ha (137 acres). The balance of the irrigation licences allow 8344 dam^3 on 3100 ha, representing an average of 20.8 ha (51 acres) per licence.

According to AAFRD[23], most private irrigation in Alberta is used to raise supplemental forages to feed livestock so most irrigation in the BRB is likely for alfalfa, hay and feed barley. Furthermore, given the small land area irrigated per licence and that only 47 of the licences specify a diversion rate that suggests pumping[24], it is reasonable to assume that most of the irrigation is backflood irrigation. It is therefore not surprising that the regional distribution of irrigation within in the BRB (Figure 4.9) generally coincides with the distribution of stockwatering (Figure 4.3), where surface water is available. It is noteworthy that licenced irrigation water use in the BRB (10,485 dam^3) is nearly double the amount of surface water that can be used for stockwatering (5,050 dam^3) and equivalent to about 70 per cent of all licenced stockwater use (14,852 dam^3).

In terms of the historical development of irrigation in the BRB, Figure 4.11 shows that the oldest irrigation licences were issued in the 1930s. It also shows that there was a significant increase in irrigation water allocations in the 1970s, with licences for about 6200 dam^3 being issued; this represents nearly half of the current allocation. Growth in irrigation water demand slowed during the 1980s and 1990s, and reached a plateau by 2000. No new irrigation licences have been issued since 1999. Over time, the amount of land being irrigated has closely matched the amount of water allocated for irrigation.

Figure 4.11

Historical Trends in Surface Water Use: Irrigation



The amount of irrigation in a particular year depends on precipitation. In wet years the amount of water consumed by backflood irrigation will be higher than in dry years, when there is less water stored in backflood projects. On average the licences issued in the BRB allow for between 257 and 267 millimetres (mm) of water (about 10 inches) per hectare of land to be irrigated. Where crops are irrigated using sprinkler irrigation, Table 4.9 shows that annual water

[23] Personal communication, Wally Chinn, Head - Irrigation Development Section, Irrigation Branch, AAFRD, January 7, 2005.

[24] These 47 licences allow withdrawals of 3326 dam^3 for irrigation on 1018 ha, which represents 23 per cent of the total area irrigated.

requirements in the BRB are estimated to be about 600 mm, with irrigation accounting for about 44 per cent in an average year. More than half of crop water requirements (53 per cent) occur in July and August, and 62 per cent of irrigation would occur during this period.

Table 4.9

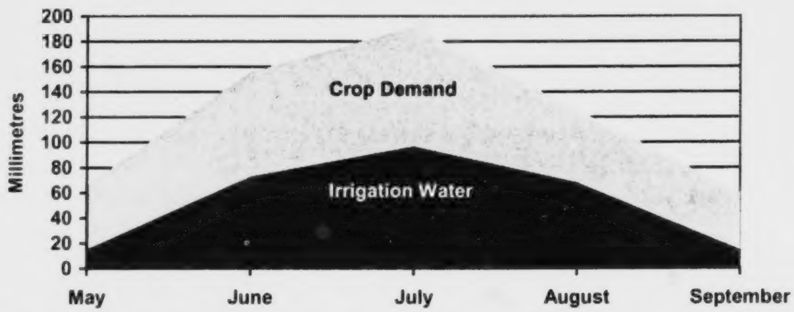
Seasonal Crop Water Demands and Irrigation Use in the Battle River Basin[25]

Month	Crop Demand		Wetaskiwin South		Stettler North	
			Precipitation	Irrigation	Precipitation	Irrigation
	Per Cent	Millimetres	Millimetres	Millimetres	Millimetres	Millimetres
May	11%	66	51.1	14.9	49.6	16.4
June	26%	156	83.2	72.8	85.7	70.3
July	32%	192	95.2	96.8	93.5	98.5
August	21%	126	57.8	68.2	65.4	60.6
September	10%	60	45.5	14.5	49.0	11.0
TOTAL	100%	600	332.8	267.2	343.2	256.8

The monthly crop water requirements and irrigation demand in the BRB is presented graphically in Figure 4.12.

Figure 4.12

Monthly Crop Requirements and Irrigation Demand



There is limited information concerning the amounts of water that irrigators in the BRB actually consume on an annual basis. Where pump irrigation occurs, crops are typically under-irrigated because of the costs of pumping, and the resulting yields are less than the optimum. Data for the SSRB suggest that, on average, district irrigators divert 81 per cent of their allocations and actually use 78 per cent of these diversions; this suggests a utilization factor of 63 per cent.[26] However, most of the irrigation in the BRB appears to be backflood irrigation (77 per cent of irrigated hectares), which has no pumping cost, so the full allocation is assumed to be utilized every year. Information provided by Ducks Unlimited for the Ribstone Creek Complex indicates that it used all of the water to which it was entitled.[27] To reflect the mix of backflood and

25 MPE Engineering Ltd. and HART Water Management Consulting (2003). *Battle River Basin in Alberta Extension of Historical Natural Flow Database 1984 to 2001.*

26 Irrigation Water Management Study Committee (2002). *South Saskatchewan River Basin: Irrigation in the 21st Century.* Volume 1: Summary Report. Alberta Irrigation Projects Association.

27 Personal communications, Rick Shewchuk Dicks Unlimited, May 4, 2005.

sprinkler irrigation in the BRB, a 95 per cent utilization factor has been assumed. This suggests average annual water use of about 9,960 dam^3.

4.3.2 Future Conditions

When the last forecast of water use in the BRB was undertaken in 1985, it concluded that "there exists a tremendous potential for the expansion of irrigation in the study area."[28] It noted that there were 1.2 million hectares of irrigable soils, that the highest potential for irrigation was in the southeast corner of the middle basin because of more favourable temperature and moisture conditions, and that irrigation of high value irrigation crops in areas of low water delivery costs would be the most economically feasible. At that time there were estimated to be 5750 ha of irrigation in the BRB. While the potential for irrigation expansion remains, the anticipated expansion of irrigation in the BRB has not occurred. In fact, irrigation from existing water licences indicates that the amount of irrigation has actually dropped by 20 per cent since1985.

There are several reasons why the anticipated expansion did not occur and is not likely to occur in the near future. First is the very high cost of adopting irrigation. As shown in Table 4.10, the cost can range from $50,000 to $100,000 for an irrigation system plus an additional $30,000 per kilometre for electric power lines.

Table 4.10

On-Farm Capital Costs of Irrigation Equipment (Electric) (2000$)

Type	Item	HAND	Wheel Roll System		Centre Pivot System	
			2 Laterals	4 Laterals	High Pressure	Low Pressure
Pivot 1300'					$58,600	$58,600
Electric Engine	125 hp	$9,850	$9,850	$9,850	9,850	9,850
Switching Gear		6,400	6,400	6,400	6,400	6,400
Vert.Turbine Pump	75-125 hp	7,100	7,100	7,100	7,100	7,100
Pump House		5,950	5,950	5,950	5,950	5,950
Suction Pipe	10"	1,330	1,330	1,330	1,330	1,330
Low Pres. Package	1300'					$4,280
Wheel Roll	1/4 mile		12,700	25,400		
Hand Move - Pipe	1/4 mile	6,000				
TOTAL		$36,630	$43,330	$56,030	$89,230	$93,510
Area/Unit (Acres)		160	160	160	132	132
Total/Acre		**$229**	**$271**	**$350**	**$676**	**$708**
Total/Hectare		$565	$669	$865	$1,670	$1,750

Source: Cost data from AAFRD/Irrigation Branch, Lethbridge, 2000.

Second, the main interest in irrigation is forage crops for feeding livestock, rather than specialty crops, and the net returns from forage production are not very great. Information from AAFRD on the production economics for hay indicates that, with irrigation, hay yields would average about 4.0 tonnes per acre compared to 2.0 and 2.5 tonnes per acres for the dark brown and black soil zones, respectively.[29] However, the contribution margins (revenues minus cash costs) for

[28] Stanley Associates Engineering Ltd. (1985) *Water Use Study Battle River Basin*. Page 4-4
[29] As reported at http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/econ8374?opendocument

irrigated hay is currently about $55 per acre, compared to between $56 and 83 per acre for the he dark brown and black soil zone. Thus, it is not economically attractive to irrigate forages unless the value of increased forage production is captured in increased beef production.

Third, in a region where water is a limiting factor for agricultural development, stockwatering represents a more effective use of water. About 122 dam^3 would be required to irrigate a quarter-section of land using a low pressure centre pivot and applying 260 mm of water. The same volume of water could be used to water about 8,000 head of cattle for one year. Given that nearly half the farms in the BRB are classified as cattle operations, it is not surprising that there has been no expansion of irrigation.

Fourth, adoption of irrigation also depends on farmers' willingness and comfort in adopting new technology. In areas where there is already an established irrigation mentality and a strong interest, such as the irrigation districts in southern Alberta, irrigation development can occur fairly rapidly. However, in areas without a history of irrigation, farmers are often reluctant to adopt new agricultural practices and technology, especially given the large costs involved.

Within the BRB, existing irrigation is quite widely scattered along the mainstem of the Battle and major tributaries, so there is not an established irrigation mentality.

For these reasons, the amount of irrigation and irrigation water use is forecast to remain relatively constant over the next 25 years, at about 9,960 dam^3 per year. Although increased frequency of drought conditions might generate some additional interest in irrigation, limited availability of water and the high capital and operating costs will discourage further irrigation development.

4.4 Other Agriculture

There is a third agricultural use of water in the basin. Greenhouses and plant nurseries can obtain water licences for commercial purposes-gardening. At present, 14 such licences have been issued to operations in the BRB. They allow diversion of up to 46 dam^3 of water, all of which can be used (i.e. no return flow). Nine licences totaling 27 dam^3 are for groundwater while the other five are for surface water (19 dam^3). Most licences were issued for the upper basin (eight licences for 30 dam^3), with the rest (six licences for 16 dam^3) in the middle basin. Within the agricultural sector, these licences for gardening account for only 0.2 per cent of water use and are relatively insignificant from the perspective of water management.

It is difficult to estimate the extent to which the number of greenhouses and nurseries may change over time because, due to the small numbers of such operations, some census data are not released due to confidentially concerns. Available information shows that, between 1996 and 2001, the number of farms growing vegetables for sale remained constant, but the acreage increased from 92 to 399 acres. The number of nurseries in the BRB is estimated to have dropped from 49 to 40 but there is no data on the size of these nurseries. Over the next 25 years the number of licences issued for gardening could increase five times over current levels but would still account for less than one per cent of agricultural water use.

4.5 Summary

In summary, current agricultural water use in the BRB is estimated to be about 24,858 dam^3, of which 40 per cent is used for irrigation and 60 per cent for stockwatering. In addition, 40 per cent of agricultural water use is groundwater and 60 per cent is surface water.

In the future, the agricultural demand for water in the BRB is expected to increase as a result of expansion of livestock populations. Demand for irrigation is expected to remain constant while water for gardening will remain insignificant. A summary of future agricultural water demand is provided in Table 4.11 and Figures 4.13 and 4.14. Under these assumptions, agricultural water use in 2015 would be about 26,950 dam^3 (an increase of 8.4 per cent from 2004) under the base case assumptions. Using the optimistic and low growth assumptions about livestock expansion in the BRB, water use in 2015 could vary from this amount by ±750 dam^3 or three per cent. Agricultural use is predicted to increase to 30,340 dam^3 by 2030; this represents a 22 per cent increase over current levels. However, this could vary by ±2,100 dam^3 or seven per cent if the High Growth and Low Growth scenarios for livestock expansion in the BRB are used.

Table 4.11

Future Agricultural Water Use in the Battle River Basin: Base Case

		2004	2010	2015	2020	2025	2030
Upper basin	Groundwater	5,367	5,629	5,858	6,095	6,343	6,600
	Surface	2,851	2,899	2,941	2,985	3,031	3,078
	Total	8,218	8,529	8,799	9,080	9,373	9,678
Middle Basin	Groundwater	3,197	3,494	3,763	4,053	4,365	4,701
	Surface	9,259	9,527	9,769	10,029	10,310	10,613
	Total	12,456	13,021	13,532	14,082	14,675	15,314
Lower Basin	Groundwater	1,883	2,059	2,218	2,389	2,574	2,773
	Surface	2,301	2,355	2,404	2,457	2,514	2,576
	Total	4,184	4,414	4,622	4,847	5,088	5,349
Battle Basin	Groundwater	10,447	11,182	11,839	12,537	13,281	14,074
	Surface	14,411	14,781	15,114	15,472	15,855	16,267
	Total	**24,858**	**25,964**	**26,953**	**28,009**	**29,137**	**30,340**

Figure 4.13

Projected Agricultural Water Use, Battle River Basin

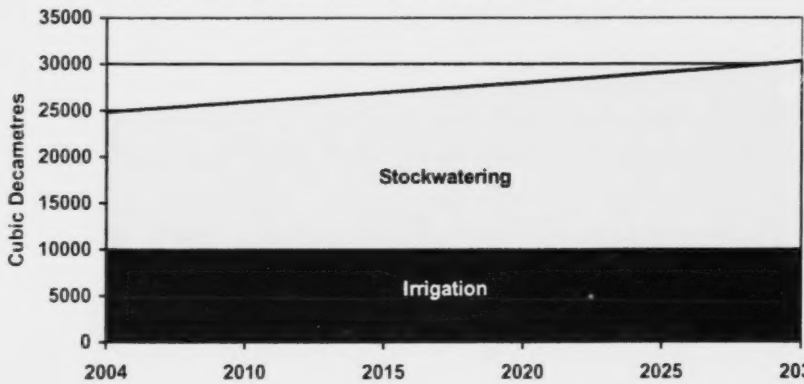
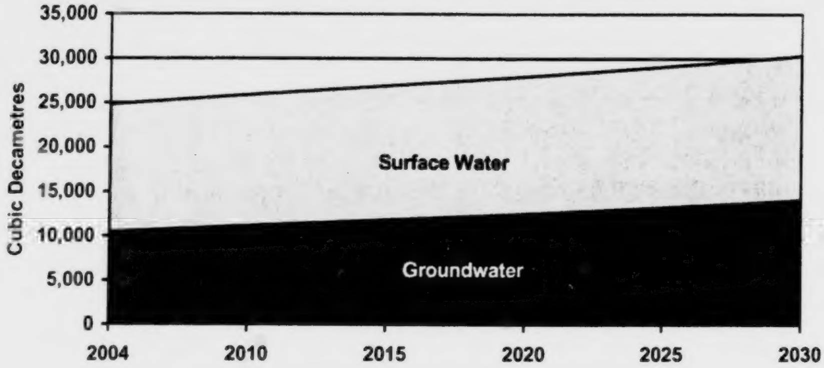


Figure 4.14

Projected Agricultural Water Use by Source, Battle Basin



5 INDUSTRIAL WATER USE

Industrial water uses account for about one-third of licenced water use in the BRB. These uses include water used for cooling (notably the ATCO thermal power plant near Forestburg), injection for oil recovery, gravel washing, construction, water hauling, and a variety of other uses. Table 5.1 summarizes surface and groundwater licences for the BRB. It shows that 117 licences have been issued for industrial purposes; groundwater use accounts for only 10 per cent of industrial licences; and, water used for cooling and injection are the key industrial water uses. In addition, Table 5.1 shows that, with the exception of water for cooling, nearly all water diverted for use can be consumed; only 1.4 per cent of diverted water must be returned to surface water bodies.

Table 5.1

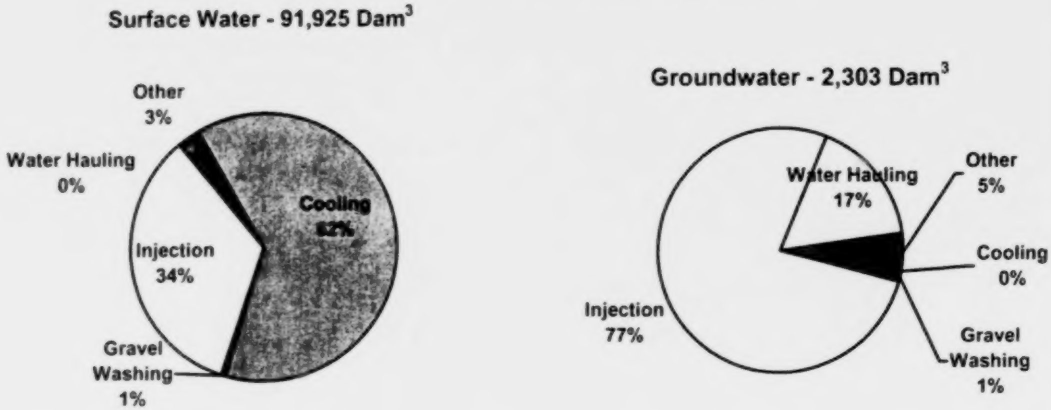
Summary of Industrial Water Licences in the Battle River Basin

Water Use	Source	Number of Licences	Allocation	Water Use	Return
				dam^3	
Cooling	Surface	3	691,737	13,741	677,996
	Groundwater	1	5	5	0
	Subtotal	4	691,742	13,746	677,996
Injection	Surface	9	7,529	7,389	140
	Groundwater	41	1,611	1,611	0
	Sub-total	50	9,140	9,000	140
Gravel Washing	Surface	5	167	167	0
	Groundwater	8	236	230	6
	Subtotal	13	403	397	6
Construction	Surface	2	19	19	0
Water Hauling	Groundwater	13	353	353	0
Other	Surface	7	659	609	50
	Groundwater	28	104	104	0
	Sub-total	35	763	713	50
	Surface	26	700,111	21,925	678,186
TOTAL	Groundwater	91	2,309	2,303	6
	Total	117	702,420	24,228	678,192

The relative importance of the various industrial water uses is illustrated in Figure 5.1. The data show that water used for cooling is responsible for 62 per cent of industrial surface water use in the BRB. Water used for oilfield injection accounts for another 34 per cent of surface water use and 77 per cent pf groundwater use. All other industrial uses account for only four per cent of surface water use and six per cent of groundwater use. These other uses included water used for gravel washing, water hauling, bottling, and an assortment of other commercial water uses.

Figure 5.1

Industrial Water Use in the Battle River Basin



The remainder of this section examines the current status of the two main industrial water uses, cooling and injection, and predicts future water use by these sectors.

5.1 Cooling: Thermal Power Generation

The most significant water use in the BRB is water used by the ATCO for thermal power production at its plant near Forestburg. As noted previously, ATCO has three water licences that allow the diversion of up to 691,737 dam^3 of water from the Battle River.

The Battle River Generating Station commenced operations in 1956.[30] The station obtained its first water licence, which allows withdrawals of up to 456,388 dam^3 per year, in 1955. To provide this water, a 13.7-metre dam was constructed on the Battle River and the resulting reservoir had a storage capacity of 10,485 dam^3. Coal for the station came from the Diplomat mine. The original station had two boilers. It was expanded in 1969 with the installation of a third boiler. A fourth boiler was added in 1975 and a second water licence was obtained in 1976. This licence allows the diversion of an additional 234,374 dam^3 of water. In 1981 the fifth boiler was added and the Paintearth mine was developed to provide coal. A third water licence for 974 dam^3 was obtained in 1988. The original two boilers were decommissioned in 2000. The Battle River Generating Station currently has a production capacity of 675 megawatts.

5.1.1 Existing Conditions

Under the terms of its licences, ATCO can actually use only two per cent of its allocation. The balance of the water (98 per cent) is returned to the Battle River after use. Maximum licenced annual use is 13,741 dam^3 and, of this, only three per cent is consumed by thermal power production. Evaporative losses during the cooling process account for 97 per cent of water use at the generating station.

[30] Information concerning the Battle River Generating Station was taken from ATCO's website at http://www.atcopower.com/our_facilities/In_North_America/BattleRiver/battle_river.htm.

According to ATCO, it diverted approximately 472,256 dam^3 in 2003.[31] This represents just over 68 per cent of its licenced entitlement. The annual usage, including evaporation, was reported as 6,247 dam^3 or 45 per cent of the amount allowed under its licences. ATCO also reported that, because of low flows in the Battle River, warm water temperatures, and additional downtime to clean their condensers due to poor water quality, its power production and use of water in 2003 were somewhat below average. For 2004, ATCO indicated that it lost approximately 20 per cent of its production capacity to all causes, including water levels and warm water temperatures. It suggested that normal water consumption would be about 70 per cent of its licenced amount, or 9,620 dam^3.

ATCO noted that water diversions and usage change from year to year depending primarily on station operation. It noted that the annual operation capacity of the station varies according to whether the units are shut down for scheduled maintenance work. Typically, each unit is on a 24-month turnaround maintenance schedule so that, in some years, ATCO will have two units off-line during the year, and only one unit will be off-line in other years. This greatly affects the station production for the year. While the station operation generally strives for maximum capacity, it usually operates at more than 85 per cent of its annual operating capacity.

Other factors affecting water use include ambient conditions, river flow, and reservoir elevation. ATCO reported that, in typical years, power production may be reduced in the summer due to warm ambient water temperatures. Under the conditions of its current approval, the station must operate within a specific reservoir water temperature range. In 2003 and 2004, the Forestburg reservoir dropped to extremely low levels so the station was forced to reduce output because of these conditions.

5.1.2 Future Conditions

No changes in the operation of the Battle River Generating Station are planned for the next 10 years. However, in 25 years the station and the Paintearth mines will be near or at the end of their economic lives and the economics of continued operation will be evaluated at that time.

With respect to future levels of water use, ATCO noted that maintaining operating efficiency is an ongoing effort but, at the present time, no changes in operating technology that would significantly reduce water consumption are being contemplated. Thus, on average, ATCO expects to use 70 to 80 percent of its licenced allocations and consumption. However, if it were able to run all its units for the entire year, its water use would approach the limits of its licences. Consequently, it indicated that it would retain its existing licences as a hedge against drought conditions and to allow full power production.

In terms of forecasting future water use, it is assumed that the Battle River Generating Plant will continue to operate over the next 25 years and will withdraw about 70 per cent of its licence entitlements or about 484,200 dam^3 per year. Future water consumption, consisting almost entirely of evaporative losses, is estimated to be 70 per cent of the maximum allowed by its licenced, or about 9,620 dam^3.

[31] Personal communications, Barb Bosh, ATCO Power, Battle River Generating Station, March 24, 2005.

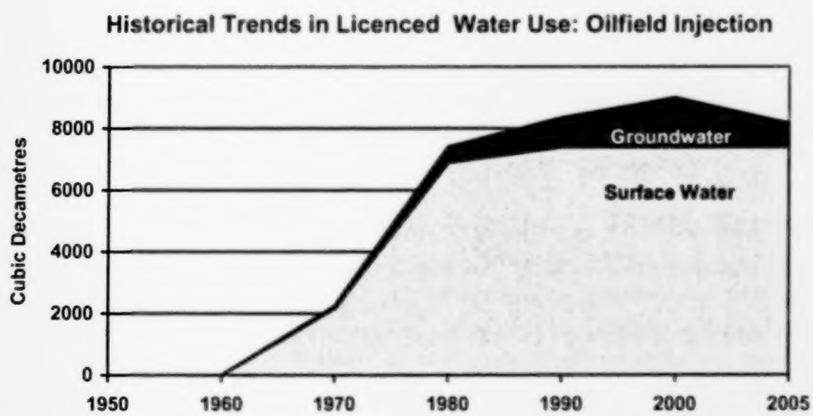
5.2 *Oil and Gas Industry*

The initial approach for producing oil is to rely on natural pressure in the oil reservoir or mechanical pumps to raise the oil to the surface. This is termed "primary recovery" and, in Alberta, the method typically captures less than 20 per cent of the oil. One approach to enhance oil recovery is to inject water or natural gas into the reservoir to maintain pressure and push oil out of the rock. The use of water-floods or injection is termed "secondary recovery". Use of water for secondary recovery is the second greatest industrial use of water in the BRB.

5.2.1 Current Status of Allocations

The first licences issued for oilfield injection in the BRB date back to the 1950s. Figure 5.2 shows that, during the 1960s and 1970s, the amount of surface water licenced for increased dramatically, reaching nearly 7000 dam^3 by 1980. Since 1980 there have been few additional allocations of surface water for injection purposes. Use of groundwater for injection started in the 1970s and then rose steadily during the 1980s and 1990s. Most of the increase in water use for injection since 1990 has been groundwater, but no new licences for oilfield injection have been issued since 1996. Groundwater allocations actually declined in 2005 because 22 groundwater licences, representing an allocation of 841 dam^3, expired on December 31, 2004.[32]

Figure 5.2



At present 28 licences allow a maximum of nearly 8300 dam^3 of water to be diverted or withdrawn for oilfield injection. A summary of these licences is provided in Table 5.2. This shows that while 19 of the 28 licences are for groundwater, licenced groundwater use amounts for only about nine per cent of total licenced water used for injection. Eight of the nine surface water licences were issued for the upper and middle basins while 92 per cent of the groundwater licences were issued for the lower basin. On average, the surface water licences for injection are about 20 times larger than the average groundwater licences. All of the water allocated for injection can be consumed; about two per cent of water from surface licences must be returned to surface water bodies. The information in Table 5.2 is presented graphically in Figure 5.3. The figure shows that the middle basin accounts for most water used for licenced oilfield injection (about 62 per cent). The greatest use of groundwater for injection can occur in the lower basin.

[32] These licences have subsequently been extended to the end of December 2006.

Figure 5.4 provides and overview of oil and gas wells drilled in the BRB as of 2004, as reported by the Alberta Geological Survey. It also shows the general locations where water licences have been issued for injection use. While the figure shows that drilling has generally occurred throughout the basin, there are areas that have been intensively drilled. These include the area northeast of Pigeon Lake, the area around Hay Lakes, east of Forestburg, north of Irma, north of Wainwright, and south of Stettler. Figure 5.4 also shows that, although injection water licences are fairly widely distributed throughout the basin, a substantial number of licences have been issued to several companies using secondary recovery at oilfields just north of Wainwright. As of late 2004 a total of 28 licences for 921 dam^3 had been issued in that area but 11 of these expired December 31, 2004, leaving 17 licences for 654 dam^3. In terms of the surface water licences, three were issued for the area north of Camrose and five were issued for various locations along the Battle River, especially southeast of Alliance.

Table 5.2

Summary of Water Licences Issued for Water Injection in the Battle River Basin

	Source	Number of Licences	Allocation (dam^3)	Water Use (dam^3)	Return (dam^3)
Upper Basin	Ground	0	0	0	0
	Surface	3	2,378	2,378	0
	Total	3	2,378	2,378	0
Middle Basin	Ground	1	58	58	0
	Surface	5	5,142	5,002	141
	Total	6	5,200	5,060	141
Lower Basin	Ground	18	712	712	0
	Surface	1	9	9	0
	Total	19	721	721	0
	Ground	19	770	770	0
TOTAL	Surface	9	7,529	7,389	141
	Total	28	8,299	8,159	141

Figure 5.3

Licenced Allocations and Water Use for Oilfield Injection by Sub-Basin

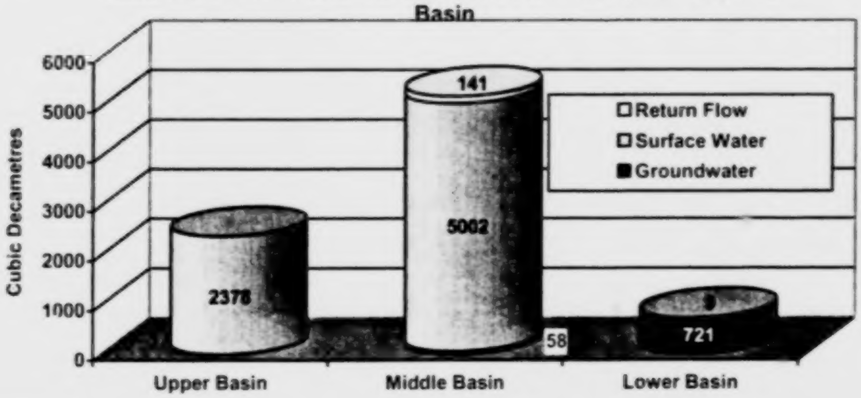
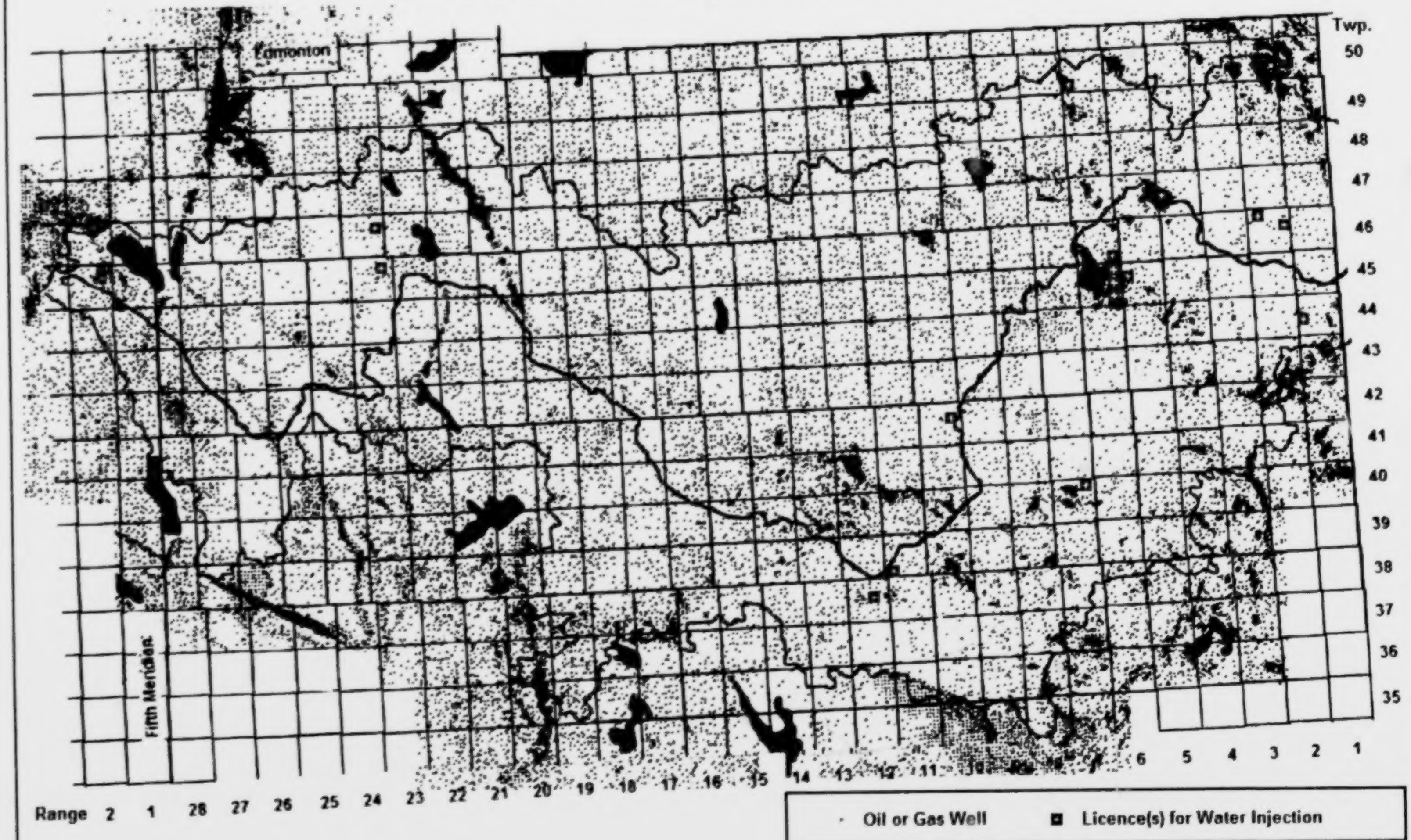


Figure 5.4

Location of Oil and Gas Wells and Water Injection Projects in the Battle River Basin



Source: http://www.ags.gov.ab.ca/GIS/gis_and_mapping.shtml and Alberta Environment water licence information.

Figure 5.4 also shows one injection licence on the northern edge of the BRB near Vermilion, but this operation draws surface water from the North Saskatchewan River. Imperial Oil Resources Ltd. also has two licences to withdraw water from the North Saskatchewan River for injection to enhance oil recovery from the Wizard Lake reservoir in the upper basin. This operation ceased in 2004 but the pipeline is still being used to pump water to the community of Thorsby. This system is currently being considered as one option for supplementing flows in the upper Battle Basin (see Section 8.1.1).

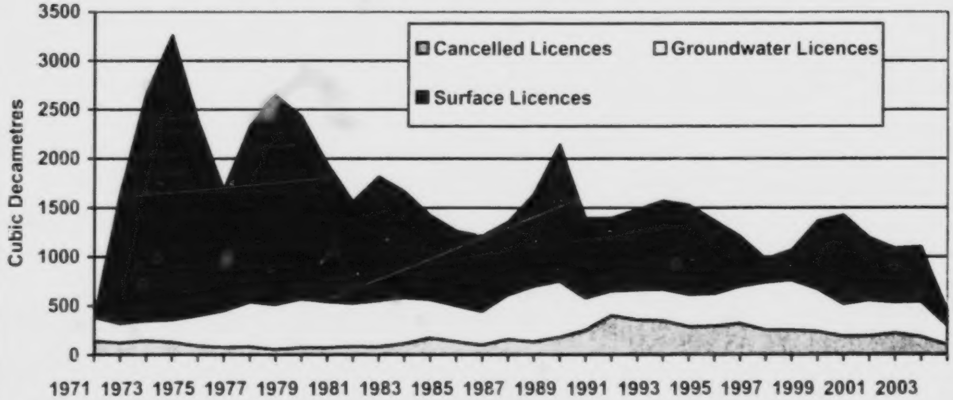
5.2.2 Actual Water Use

Data on actual water use for oilfield injection is collected by the Alberta Energy and Utilities Board (EUB).[33] The EUB provided historical information for the various projects that had licences, including the 22 licences that expired at the end of December 2004. The resulting data are provided in Figure 5.5 and show that licenced water use has been dropping steadily since the early 1970s. The figure also shows that, while use of groundwater has remained relatively constant over time at between 300 and 350 dam^3 per year, surface water use has fluctuated considerably. Annual use was 1445 dam^3 in 1989, dropped to 290 dam^3 in 1997, and increased to 933 dam^3 in 2000.

Actual water use represents only a fraction of the licenced allocations. For the surface water licences, actual water use in 2004 was only 153 dam^3, which represents two per cent of the licenced volume (7,529 dam^3). During the early 1990s, between 10 and 12 per cent of licenced surface water allocations were actually being used. For groundwater, 191 dam^3 were actually used and this represents 25 per cent of licenced allocations. This water information suggests that there is considerable unused capacity in surface water licences. In contrast, the recently completed natural flow study[34] assumed that 65 per cent of licenced surface allocations were being used and, as a result, the calculated natural flows may actually be lower than estimated.

Figure 5.5

Actual Licenced Water Use for Injection Purposes

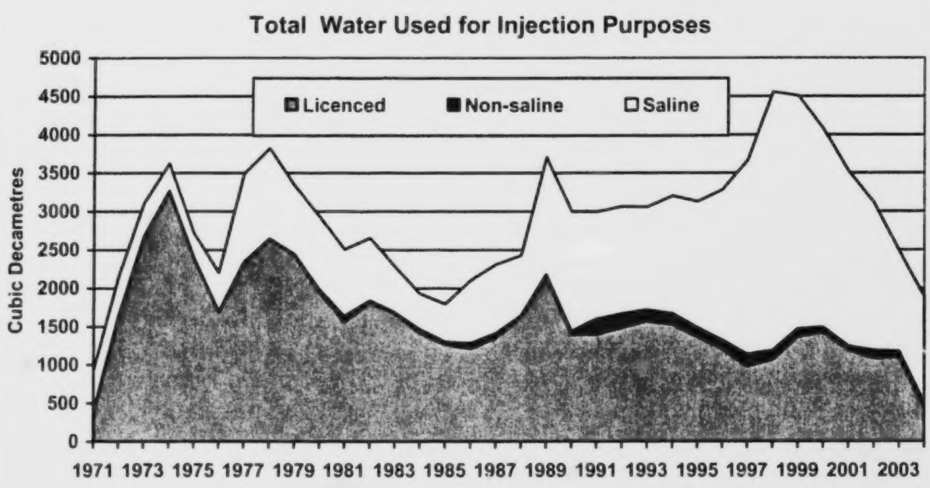


[33] The efforts of Ms. Cheryl Adolf of the EUB, who spent many days producing the raw data on water use for oil field injection, are greatly appreciated.

[34] MPE Engineering Ltd. and HART Water Management Consulting (2003). *Battle River Basin in Alberta Extension of Historical Natural Flow Database 1984 to 2001*

The information provided by the EUB indicates that oilfield injection is only partly reliant on licenced water sources. Oil companies can use saline water for injection without having to acquire a water licence. Current records indicate that there are 155 unlicenced wells that provide water for oilfield injection and, in 2004, they provided 1440 dam^3 of water. As shown in Figure 5.6, the oil industry in the BRB has consistently used more saline water and small amounts of unlicenced non-saline water for injection purposes, than licenced potable water. It also shows that, while use of unlicenced saline water increased substantially during the early 1990s, water use has dropped significantly since then. In 2004, saline water accounted for 76 per cent of total water used by the oil industry in the BRB.

Figure 5.6



Future Conditions

In Alberta there is a general trend toward reduced production of conventional crude oil, with fewer new finds and reduced production from existing fields. The most recent forecast from the EUB suggests that average daily production of conventional crude will drop from 65,800 m^3 in 2003 to 42,000 m^3 by 2013.[35] This forecast is presented in Figure 5.7 and suggests an average decrease of about five per cent per year due to the failure of new wells to offset declining production from existing wells.

Oil production in the BRB is expected to exhibit a similar trend since most production is from existing wells where water is being used for secondary recovery. Since oil production is correlated with water use, the data in Figures 5.5 and 5.6 show that oil production from fields in the BRB has been declining, especially in the last five or ten years.

[35] Energy and Utility Board (2004) *Alberta's Reserves 2003 and Supply/Demand Outlook 2004-2013*

Figure 5.7

Historic and Projected Daily Production of Crude Oil in Alberta

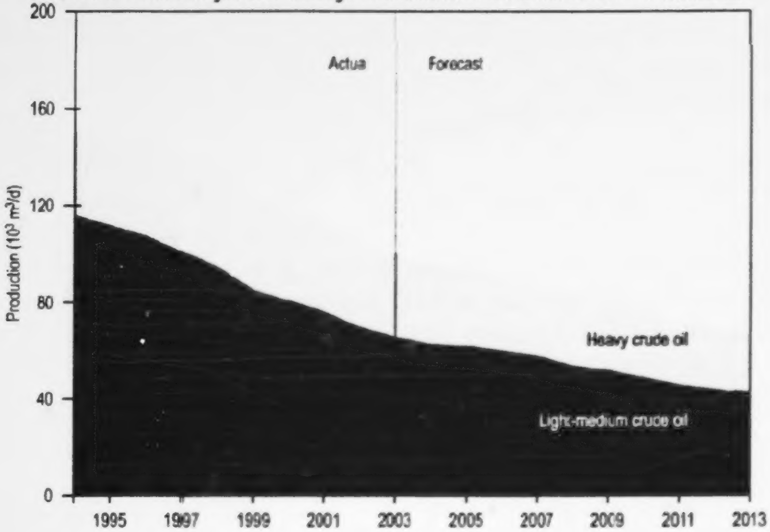


Table 5.3

Historical Use of Water for Oilfield Injection by Field in the BRB

Field	# of Wells	Water Production (dam³)	Water Production % of Total	Saline Water (dam³)	Non-Saline Water (dam³)	Historic Change Since 1994	Historic Change Since 1999
Chauvin	6	115.6	6.9%	115.6	0	73%	-31%
Chauvin South	1	0	0.0%	0	0	-	-
Dolcy	4	0	0.0%	0	0	-	-
Duhamel	1	0	0.0%	0	0	-	-
Ferrybank	3	0	0.0%	0	0	-	-86%
Gadsby	3	0	0.0%	0	0	-	-
Halkirk	17	155.6	9.3%	155.6	0	-70%	-40%
Killam	1	28	1.7%	28	0	-	-
Leahurst	1	26.9	1.6%	26.9	0	-38%	-28%
Lloydminster	2	0	0.0%	0	0	-	-
Provost	18	106.9	6.4%	56.8	50.1	-58%	158%
Red Willow	1	11.7	0.7%	11.7	0	-	-
Ribstone	4	0.7	0.0%	0.7	0	-	-
Viking-Kinsella	66	757.9	45.2%	757.9	0	-51%	-11%
Wainwright	42	214.3	12.8%	77.4	136.8	-40%	-50%
Wildmere	4	258.2	15.4%	151.4	106.8	-40%	29%
Wood River	1	2.6	0.2%	1.6	0	-88%	-90%
TOTAL	175	1678.4	100.0%	1383.6	293.7	-20%	-54%

This downward trend is consistent throughout the basin. EUB data indicate that water injection is used in 17 fields, and water use data for each of these fields shows a significant decrease. This information is summarized in Table 5.3. Five of these fields (Halkirk, Provost, Viking-Kinsella, Wainwright, and Wildmere) account for 89 per cent of water used for secondary recovery. Water use data show that injection volumes for these fields have dropped by about 20 per cent since 1994 and by more than half (54 per cent) since 1999. This pattern is consistent among all the fields in the BRB.

To forecast future licenced water use in the BRB, the Base Case assumes that water use will continue to decline from 2004 levels, but not quite as rapidly as the five per cent annual decrease in oil production forecast by the EUB. For the Base Case, the annual reduction is assumed to be 2.5 per cent per year. The High Growth scenario assumes that licenced water use for injection remains contact throughout the forecast period. As a Low Growth scenario, an annual decrease of 5.0 per cent is assumed. The water use projections resulting from these assumptions are provided in Table 5.3. Under the Base Case, water use will drop by 25 per cent over the next 10 years and by half over the next 25 years.

Table 5.4

Forecast of Future Water Injection in the Battle River Basin (dam^3)

		2005	2010	2015	2020	2025	2030
Base Case	Surface	149	131	116	102	90	79
	Ground	186	164	145	127	112	99
	Total	335	296	260	229	202	178
High Growth	Surface	153	153	153	153	153	153
	Ground	191	191	191	191	191	191
	Total	344	344	344	344	344	344
Low Growth	Surface	145	112	87	67	52	40
	Ground	181	140	109	84	65	50
	Total	327	253	196	151	117	91

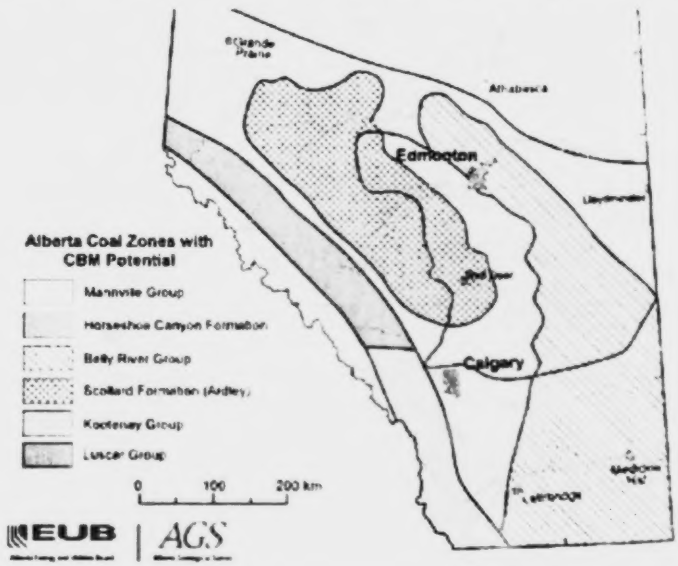
One area of future interest is expected to be the impact of coal-bed methane on groundwater resources. Coal-bed methane is natural gas contained in coal, and production may result in the production of various amounts of saline and non-saline water that may require disposal. There are concerns that improper disposal may compromise groundwater and surface water quality.

Most of the upper portion of the BRB is situated above the Horseshoe Canyon/Belly River coal zones (see Figure 5.5) and, according to the EUB, most of the wells drilled for coal-bed methane from these formations have essentially produced no water.[36] The lower BRB overlays the deeper Mannville coal zone and coal-bed methane wells in drilled in these locations have produced saline water that is typical of other oil and gas development and must be managed using deep well disposal. The uppermost reaches of the Battle River are located above the shallower Scollard (Ardley) coal zone and test wells in this zone have produced limited amounts of water that varies in quality.

[36] As stated as http://www.eub.gov.ab.ca/BBS/public/EnerFAQs/EnerFAQs10.htm.

Figure 5.8

Coal Zones in Southern Alberta with Coal-Bed Methane Potential



Water produced from any wells, including those for coal-bed methane, are regulated by both the EUB and Alberta Environment. If the produced water is found to be non-saline and suitable for domestic, farm, or other surface use, the production and final disposition of this water is reviewed by both the EUB and Alberta Environment to ensure that it is handled in an environmentally responsible way and a groundwater diversion licence may be required. If the produced water is saline, the disposition of the water is regulated by the EUB, which may require saline water to be injected into deep wells. The EUB also notes that current well drilling and completion practices have been developed to ensure the protection on non-saline aquifers.

5.3 *Other Industrial Uses*

Table 5.1 shows that water licences have been issued for a number of other industrial water uses including gravel washing, construction, water hauling, and various other purposes. While licences issued for other industrial purposes comprise 54 per cent of all industrial licences, they account for just over six per cent of licenced industrial water use.

5.3.1 Existing Conditions

Sixty-three water licences have been issued for other industrial purposes, and the total allocation is 1,538 dam^3. These are summarized by water source and sub-basin in Table 5.4 and Figure 5.6. Over three-quarters of these licences were issued for groundwater, accounting about 46 per cent of licenced water use. About 60 per cent of both surface and groundwater use can occur in the upper basin. The licences allow 96 per cent of the allocations to be used; return flow accounts for about three per cent of allocations. This return flow occurs in the upper and middle basins.

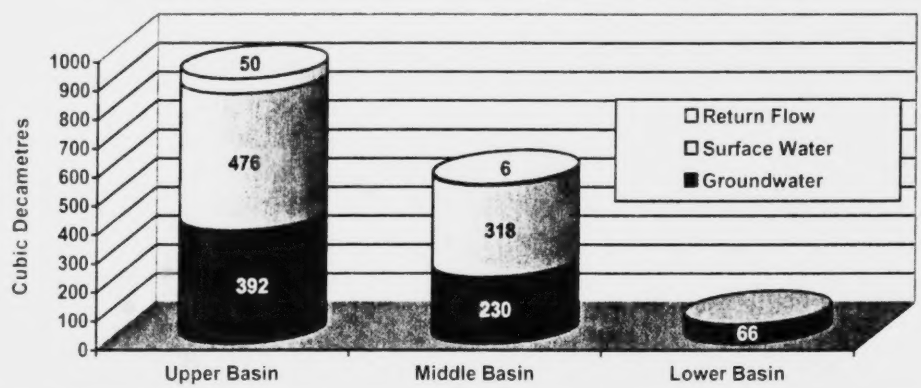
Table 5.5

Summary of Other Industrial Water Licences by Sub-basin

	Source	Number of Licences	Allocation	Water Use	Return
				dam³	
	Surface	9	526	476	50
Upper Basin	Groundwater	21	392	392	
	Subtotal	30	918	868	50
	Surface	5	318	318	
Middle Basin	Groundwater	26	236	230	6
	Subtotal	31	554	548	6
Lower Basin	Groundwater	2	66	66	
	Surface	14	844	794	50
Battle Basin	Groundwater	49	694	688	6
	Subtotal	63	1538	1482	56

Figure 5.9

Licenced Allocations and Water Use for Other Industrial Use by Sub-Basin



The most important of these other industrial uses is water used for gravel (aggregate) washing. Thirteen licences have been issued for this purpose and allow 396 dam³ of water to be used, primarily groundwater in the upper basin. Licences for surface water were originally issued in the 1970s and 1980s, but all eight groundwater licences were issued after 1990.

Groundwater hauling is another significant other industrial use. As shown in Table 5.5, 13 licences have been issued for 353 dam³ of water. They were issued to municipal governments, including Ponoka County (two licences), Camrose County (one), Flagstaff County (five), Paintearth (two), Stettler (two) and Wainwright (one). Accordingly, most were issued in the middle and upper basins. All were issued in 2003 in response to drought conditions.

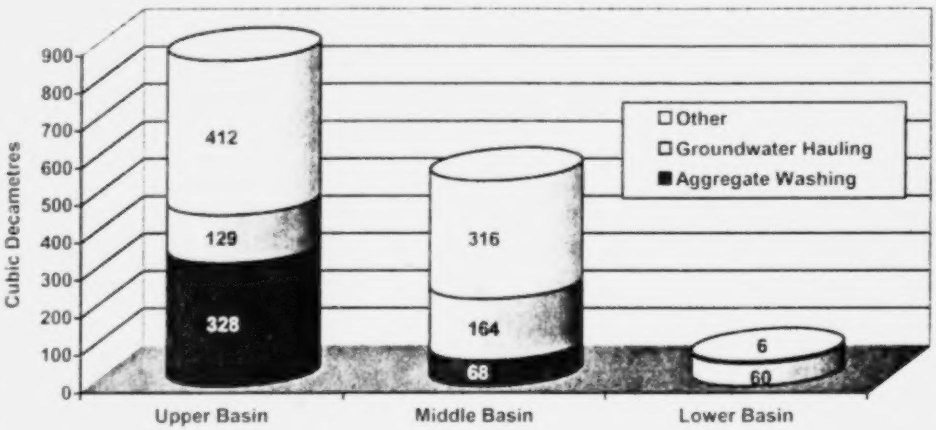
Table 5.6

Summary of Other Industrial Water Licences by Type of Use (dam^3)

	Upper Basin		Middle Basin		Lower Basin		Battle Basin	
	Licences	Water Use	Licences	Water Use	Licences	Water Use	Licences	Water Use
Gravel Washing	8	328	5	68	0	0	13	396
Bottling	1	1	1	1	0	0	2	2
Construction	2	19	0	0	0	0	2	19
Groundwater Hauling	3	129	9	164	1	60	13	353
Other	16	392	16	315	1	6	33	713
TOTAL	**30**	**868**	**31**	**548**	**2**	**66**	**63**	**1482**

Figure 5.10

Other Industrial Water Use by Sub-Basin



Note that "other" includes licences for construction and bottling purposes.

Two licences have been issued for water bottling. These operations are located near Irma and west of Pigeon Lake and allow nearly two dam^3 of groundwater to be produced. The two licences for construction purposes in the upper basin were issued after 1998.

The "other" category in Table 5.5 includes licences issued for manufacturing, agricultural processing, oilfield servicing, dust control, cement plants, and retail stores. As shown in Table 5.5, these other licences were almost equally split between the upper and middle basins, with only one issued for the lower basin. Although two licences date back to 1920 and 1930 (both for creameries), the majority have been issued since 1980.

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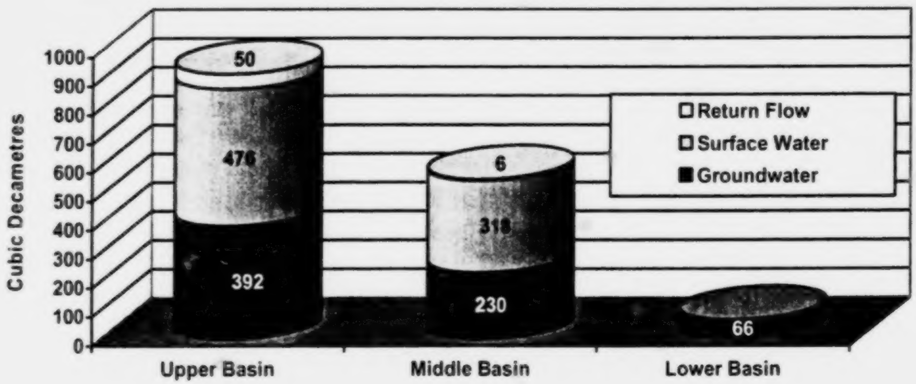

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Gravel Washing	8	328	5	68	0	0	13	396
Bottling	1	1	1	1	0	0	2	2
Construction	2	19	0	0	0	0	2	19
Groundwater Hauling	3	129	9	164	1	60	13	353
Other	16	392	16	315	1	6	33	713
TOTAL	**30**	**868**	**31**	**548**	**2**	**66**	**63**	**1482**

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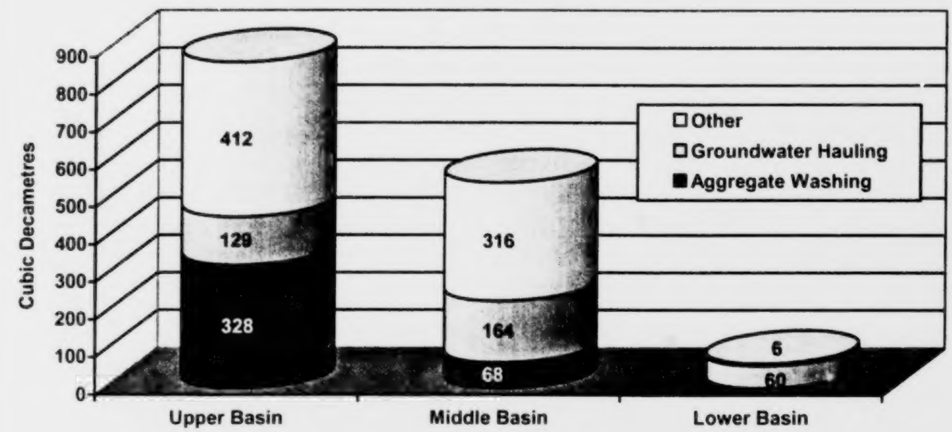

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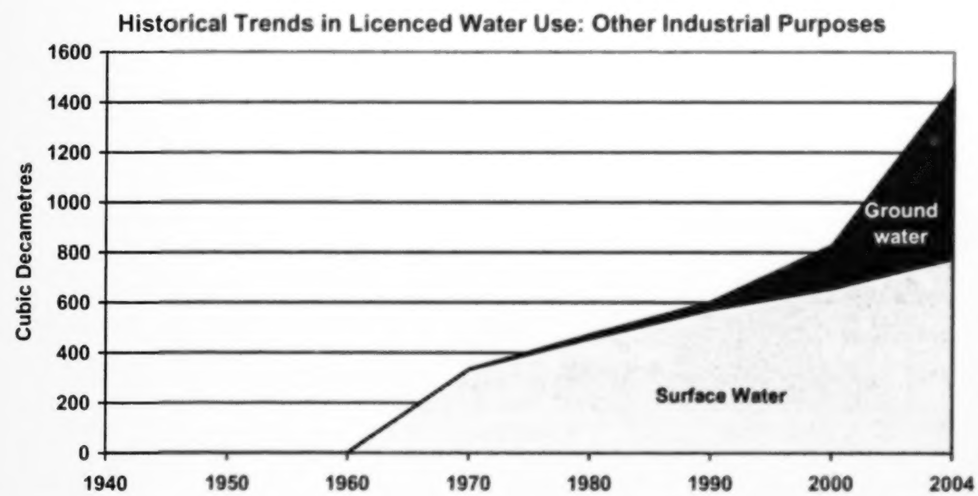
There is no information regarding actual water use for other industrial purposes. For some uses, such as groundwater hauling, it is likely that actual use could vary significantly from year to year, since demand would depend on regional moisture conditions. For other uses, like gravel washing, annual use depends on the amount of activity in the construction industry and the associated demand for gravels and concrete products. For purposes of this analysis it is assumed that actual water use is equivalent to licenced water use.

5.3.2 Future Conditions

The demand for water for other industrial purposes is likely to increase in future years. As the regional economies diversify, especially in the upper basin, operations involved in manufacturing, agricultural processing, and gravel for construction and concrete will require additional water. As shown in Figure 5.11, there has been a significant increase in demand for other purposes since 1990. Since 2000 water demand for other industrial water uses has increased by more than 600 dam^3 (75 per cent), although nearly half of this was for groundwater hauling as a result of drought. Prior to 2000, other industrial demand for water increased by about 200 dam^3 per decade.

Figure 5.11



For forecast purposes, it assumed that the demand for other industrial water will increase by about 300 dam^3 per decade, reaching 1,785 dam^3 by 2015 and 2,230 dam^3 by 2030. About 50 per cent of this demand is assumed to be in the upper basin, 45 per cent in the middle basin, and five per cent in the lower basin. The Low Growth scenario would see other industrial water demand increasing by 200 dam^3 per decade, while the High Growth scenario would see demand increase by 400 dam^3.

Table 5.7

Forecast of Future Other Industrial Water Use in the Battle River Basin (dam^3)

		2005	2010	2015	2020	2025	2030
Base Case	Surface	794	875	955	1035	1115	1195
	Ground	688	760	830	900	970	1040
	Total	1482	1635	1785	1935	2085	2235
High Growth	Surface	794	900	1005	1110	1215	1320
	Ground	688	785	880	975	1070	1165
	Total	1482	1685	1885	2085	2285	2485
Low Growth	Surface	794	850	900	955	1010	1060
	Ground	688	735	785	830	875	925
	Total	1482	1585	1685	1785	1885	1985

While these increases appear to be significant, from the perspective of total water demand in the BRB, other industrial demand would still account for less than 3.5 per cent of total water use by 2030.

5.4 Summary

Table 5.8 shows that, while current licences allow up to 23,381 dam^3 of industrial water use in the BRB, the estimated actual water use in 2004 for these licences was only 8,697 dam^3, or 37 per cent of the licenced amount. The utilization rate varied between 36 per cent for surface water licences and 60 per cent for groundwater licences. Over the next 10 years, industrial water use is forecast to increase by 2.6 per cent under the Base Case, which assumes water use for cooling will remain constant, injection use will decline, and other industrial demands will rise steadily. Over the next 25 years, a 6.8 per cent increase over 2004 levels is predicted for the Base Case. The High Growth scenario, which assumes higher other industrial demands, would see an increase of 4.7 per cent by 2015 and 11.5 per cent by 2030. The Low Growth scenario predicts a 0.7 per cent increase over 10 years and 3.1 per cent over 25 years. In all cases, industrial water use would still amount to a maximum of 41 per cent of existing allocations. Some additional licences would have to be issued to accommodate other industrial water uses, however.

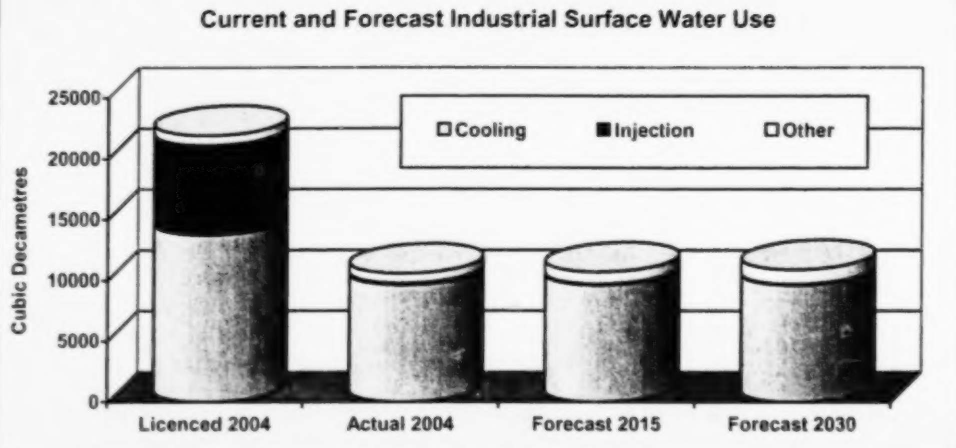
Table 5.8

Forecast of Future Industrial Water Use in the Battle River Basin (dam^3)

		Licenced	Actual	Forecast				
		2004	2004	2010	2015	2020	2025	2030
Base Case	Surface	21,923	7,813	7,876	7,941	8,007	8,075	8,144
	Ground	1,458	874	924	975	1,027	1,082	1,139
	Total	23,381	8,687	8,801	8,915	9,034	9,157	9,283
Low Growth	Surface		7,817	7,923	8,028	8,133	8,238	8,343
	Ground		879	976	1,071	1,166	1,261	1,356
	Total		8,696	8,899	9,099	9,299	9,499	9,699
High Growth	Surface		7,809	7,832	7,857	7,892	7,932	7,970
	Ground		869	875	894	914	940	975
	Total		8,679	8,708	8,751	8,806	8,872	8,946

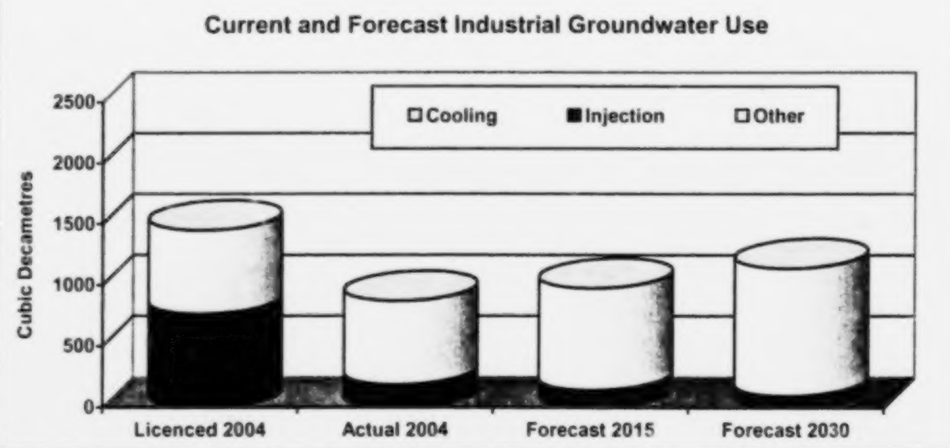
The forecasts in Table 5.8 are presented graphically for surface water in Figure 5.12 and for groundwater in Figure 5.13. Figure 5.12 shows that, over the forecast period, water used for cooling at the Battle River Generating Station, will account for the vast majority of surface water use. Surface water use for injection purposes will be relatively insignificant.

Figure 5.12



In terms of groundwater, other industrial uses will continue to amount for the majority of water use throughout the forecast period. Groundwater will also continue to account for just over 12 per cent of total industrial water use.

Figure 5.13



6 OTHER WATER USES

Nearly nine per cent of water licences issued in the BRB are for purposes other than municipal and residential, agricultural, or industrial water use. These licences were issued for recreational purposes, wildlife management, water management, and a small number of other purposes.

6.1 Recreation

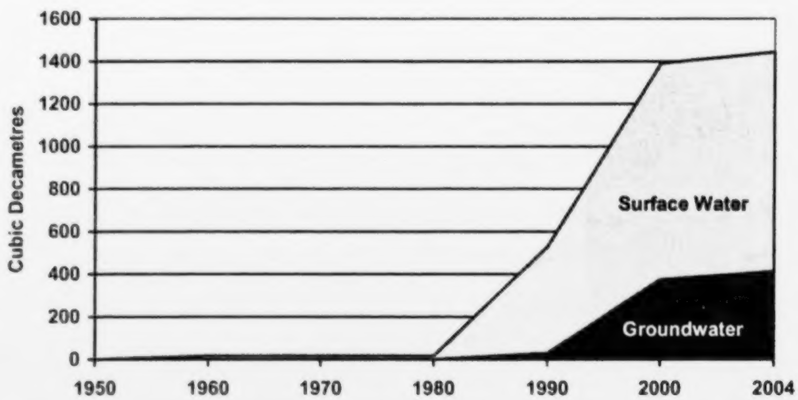
Analysis of water licence information indicates that water licences have been issued for three types of recreational activities: golf courses, ski hills, and general recreation.

6.1.1 Existing Conditions

Some water allocations for recreational purposes date back to the 1950s but significant allocations of water were made in the 1980s. Figure 6.1 shows that, during the 1980s, significant amounts of surface water have been allocated for recreational purposes. In the 1990s, most new allocations for recreation were groundwater. Since 2000 the amount of additional water being allocated to new recreational projects has decreased, but most allocations have been for groundwater.

Figure 6.1

Historical Trends in Licenced Recreational Water Use



Currently, 55 licences exist for recreational purposes. Twenty of these are for surface water and 35 are for groundwater. A total of 1,867 dam^3 of water has been allocated for recreational purposes and, of this, a maximum of 1,617 dam^3 can be used and the balance (250 dam^3) is returned to surface water sources. A summary of these recreational licences is provided in Table 6.1. The table shows that nearly half the licences and about 72 per cent of licenced water use are for recreational projects in the upper basin. Recreational projects in the middle basin account for 22 per cent of licenced water use, while the lower basin accounts for the remaining six per cent. The majority of the return flow requirements are contained in surface water licences issued to projects in the upper basin.

Table 6.1

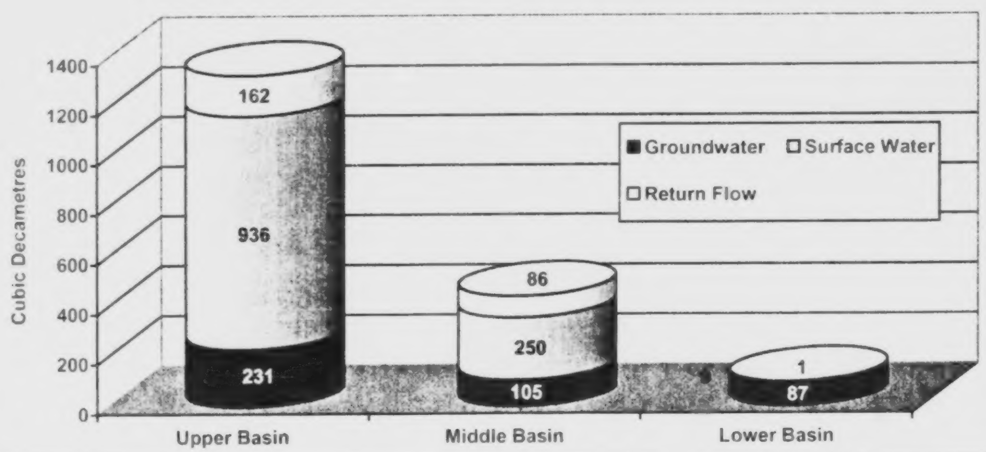
Summary of Recreation Water Licences by Sub-basin

	Source	Number of Licences	Allocation	Water Use	Return
				Dam^3	
Upper Basin	Surface	13	1,099	936	162
	Ground	13	231	231	0
	Total	26	1,329	1,167	162
Middle Basin	Surface	6	336	250	86
	Ground	14	105	105	0
	Total	20	441	355	86
Lower Basin	Surface	1	10	9	1
	Ground	8	87	87	0
	Total	9	97	96	1
Battle Basin	Surface	20	1,444	1,195	250
	Ground	35	423	423	0
	Total	55	1,867	1,617	250

Figure 6.2 provides a graphical representation of the data in Table 6.1, and clearly shows that the majority of recreational water use occurs in the upper basin, for both surface and groundwater.

Figure 6.2

Licenced Allocations and Water Use for Recreation by Sub-Basin



Over half of the recreational water licences have been issued to golf courses. As described in Table 6.2, 29 licences have been issued to golf courses: seven for surface water and 22 for groundwater. The total licenced water use for golf courses is 1,107 dam^3, two-thirds of which is for surface water. Within the BRB, a nearly equal number of licences were issued in the upper and middle basins, but 68 per of licenced water use occurs in the upper basin. Relative water use among the sub-basins is shown in Figure 6.3. While recreational water use in the lower basin is relatively small, the four licences issued to golf courses account for nearly 74 per cent of that use.

Table 6.2

Summary of Recreation Water Licences by Purpose by Sub-basin

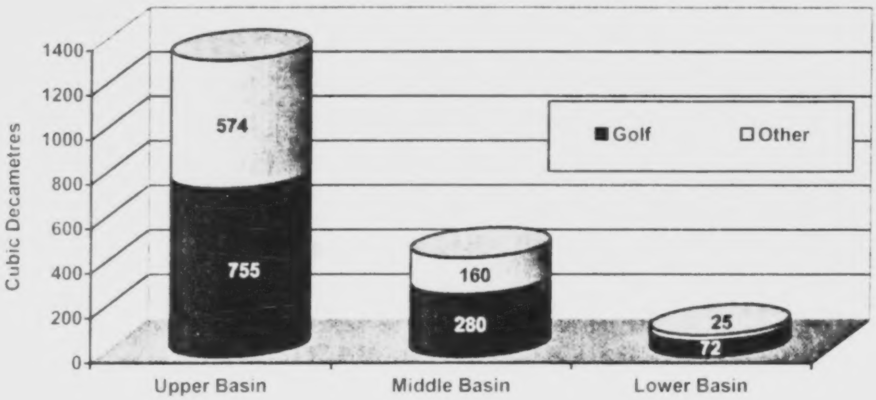
		Golf Courses		Ski Facilities		Other		Total	
		Licences	Water Use	Licences	Water Use	Licences	Water Use	Licences	Water Use
Upper Basin	Surface	5	540	0	0	8	558	13	1099
	Ground	7	215	0	0	6	16	13	231
	Total	12	755	0	0	6	574	26	1329
Middle Basin	Surface	2	194	1	51	3	91	6	336
	Ground	11	86	1	16	2	2	14	104
	Total	13	280	2	67	5	93	20	440
Lower Basin	Surface	0	0	0	0	1	10	1	10
	Ground	4	72	1	10	3	5	8	87
	Total	4	72	1	10	4	15	9	97
Battle Basin	Surface	7	734	1	51	12	660	20	1445
	Ground	22	373	2	26	11	23	35	421
	Total	29	1107	3	77	23	683	55	1866

Three licences have been issued for snowmaking at ski hills, two in the middle basin and one in the lower basin. The total water use for ski hills is very small, however, amounting to only 77 dam^3 or four per cent of recreational water use.

A total of 23 licences for 683 dam^3 account for the remainder of licenced recreational water use; nearly 85 per cent of this is for surface water in the upper basin. Many of these licences have been issued to private individuals or to municipal governments.

Figure 6.3

Licenced Recreational Water Use by Sub-Basin



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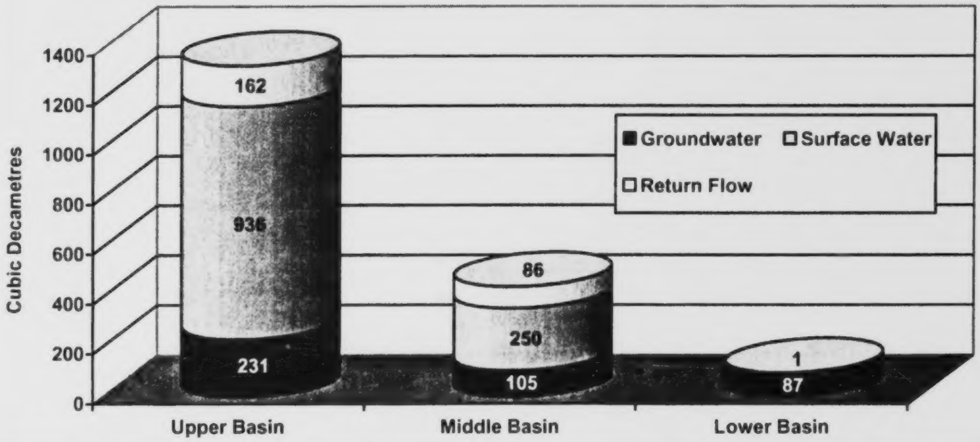
Licenced Allocations and Water Use for Recreation by Sub-Basin



Over half of the recreational water licences have been issued to golf courses. As described in Table 6.2, 29 licences have been issued to golf courses: seven for surface water and 22 for groundwater. The total licenced water use for golf courses is 1,107 dam^3, two-thirds of which is for surface water. Within the BRB, a nearly equal number of licences were issued in the upper and middle basins, but 68 per of licenced water use occurs in the upper basin. Relative water use among the sub-basins is shown in Figure 6.3. While recreational water use in the lower basin is relatively small, the four licences issued to golf courses account for nearly 74 per cent of that use.

Table 6.2

Summary of Recreation Water Licences by Purpose by Sub-basin

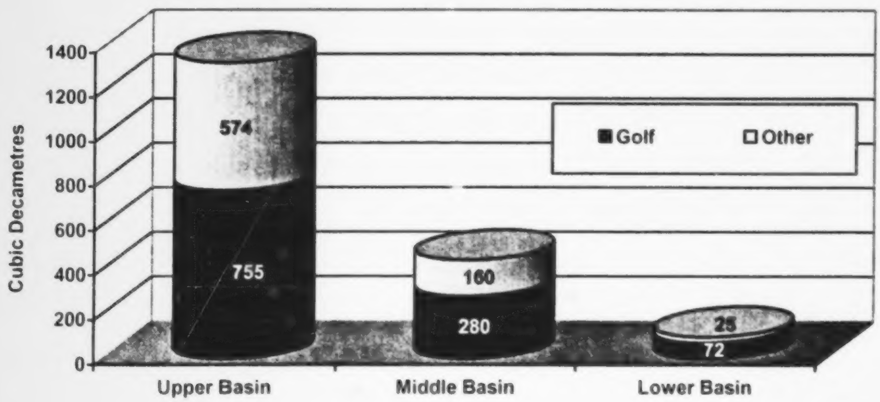
		Golf Courses		Ski Facilities		Other		Total	
		Licences	Water Use	Licences	Water Use	Licences	Water Use	Licences	Water Use
Upper Basin	Surface	5	540	0	0	8	558	13	1099
	Ground	7	215	0	0	6	16	13	231
	Total	12	755	0	0	6	574	26	1329
Middle Basin	Surface	2	194	1	51	3	91	6	336
	Ground	11	86	1	16	2	2	14	104
	Total	13	280	2	67	5	93	20	440
Lower Basin	Surface	0	0	0	0	1	10	1	10
	Ground	4	72	1	10	3	5	8	87
	Total	4	72	1	10	4	15	9	97
Battle Basin	Surface	7	734	1	51	12	660	20	1445
	Ground	22	373	2	26	11	23	35	421
	Total	29	1107	3	77	23	683	55	1866

Three licences have been issued for snowmaking at ski hills, two in the middle basin and one in the lower basin. The total water use for ski hills is very small, however, amounting to only 77 dam^3 or four per cent of recreational water use.

A total of 23 licences for 683 dam^3 account for the remainder of licenced recreational water use; nearly 85 per cent of this is for surface water in the upper basin. Many of these licences have been issued to private individuals or to municipal governments.

Figure 6.3

Licenced Recreational Water Use by Sub-Basin

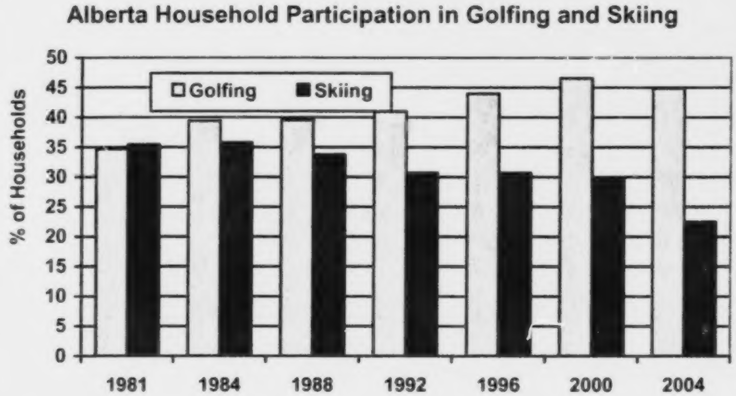


There is no information on the actual amounts of water being used for recreational purposes. It is likely that seasonal water use at golf courses would match irrigation practices with the bulk of water use being during the summer months and dependent on amounts of natural precipitation. For ski hills, the withdrawals would be during the winter months. For purposes of this assessment, it is assumed that actual water use is equal to licenced water use.

6.1.2 Future Conditions

Future demand for water for recreational purposes will depend on future participation in the two major recreational uses of water: golf courses and ski hills. Historical trends in Alberta household participation in golfing and skiing since 1981 are shown in Figure 6.4, which is based on data provided by the Alberta Recreation Surveys undertaken by Alberta Community Development.[37] The data show that, while household participation for downhill skiing has declined steadily since 1984, demand for golfing has climbed steadily, reaching a peak in 2000.

Figure 6.4



These data, combined with a growing number of households in the BRB, and specifically the upper basin, explain why there was a proliferation of golf course development during the 1990s. Water licence data indicates that 14 golf courses currently hold 29 licences and all but six licences were issued after 1989, either for new courses or for golf course expansions. However, only two licences were issued after 2000. The two licences for ski hills were issued in 1993 and 1997.

In the future, the number of licences for ski hills is not expected to increase, with the two operations continuing to accommodate local demand. For golfing, the demand for new golf courses or course expansions is expected to continue in the upper basin as the population continues to grow and the ageing population has more leisure time. As a Base Case, it is predicted that 18 new holes of golf will be developed every five years, either as new courses or as expansion of existing golf courses. This means 36 new holes by 2015 and 90 new holes by 2030. A review of existing licence data suggest that average water demands for golf courses amount to about 2.0 dam^3 per hole or 36 dam^3 per 18-hole course. The Low Growth scenario

[37] This information can be found at http://www.cd.gov.ab.ca/building_communities/sport_recreation/recreation_survey/index.asp.

assumes that only nine new holes or 18 dam^3 of water demand will be added every five years. For the High Growth scenario, it is assumed that 27 new holes or 54 dam^3 will be added every five years.

Using these assumptions, the resulting forecasts of water demands for recreational purposes are provided in Table 6.3. Under the Base Case, water use in 2015 would be four percent greater than in 2004 and would be 11 per cent higher in 2030. All of the increased demand is assumed to be for groundwater. The Low Growth and High Growth scenarios suggest that, by 2030, estimated recreational water use would be ±90 dam^3 or five per cent compared to current use.

Table 6.3

Forecast of Future Recreational Water Use in the Battle River Basin (dam^3)

		2005	2010	2015	2020	2025	2030
Base Case	Surface	1,195	1,195	1,195	1,195	1,195	1,195
	Ground	423	459	495	531	567	603
	Total	1,618	1,654	1,690	1,726	1,762	1,798
High Growth	Surface	1,195	1,195	1,195	1,195	1,195	1,195
	Ground	423	477	531	585	639	693
	Total	1,618	1,672	1,726	1,780	1,834	1,888
Low Growth	Surface	1,195	1,195	1,195	1,195	1,195	1,195
	Ground	423	441	459	477	495	513
	Total	1,618	1,636	1,654	1,672	1,690	1,708

6.2 *Fisheries and Wildlife Management*

Water used for fisheries and wildlife management consists entirely of surface water and accounts for a significant portion (29 per cent) of licenced water use in the basin. Most of this is for wildlife management, which involves catching and controlling spring run-off to create water fowl habitat as well as opportunities for backflood irrigation.

6.2.1 Existing Conditions

Eleven licences allocate 209 dam^3 for fisheries management. Four were issued to the provincial government, four were issued to municipal governments, and three to private individuals. The oldest was issued in the 1940s, and they have been issued at the rate of one or two per decade since then. The most recent licence for fisheries management was issued in 1998. Within the BRB, five licences for 95 dam^3 have been issued in each of the upper and middle basins. Only one licence for fisheries management for 19 dam^3 has been issued for the lower basin.

Water licences issued for wildlife management include 33 licences for water management-stabilization and 79 licences for habitat management-wetlands. A review of licence holders indicates that 100 of these are licenced to or operated on behalf of Ducks Unlimited. Although a few licences for wildlife management were issued prior to 1970, there was a significant increase in the 1970s. As shown in Figure 6.5, most allocations for wildlife management occurred during the 1980s with an increase of 9,600 dam^3. Another 4,800 dam^3 was allocated during the 1990s, but only one new licence has been issued since 1999.

Figure 6.5

Historical Trends in Surface Water Use for Wildlife Management

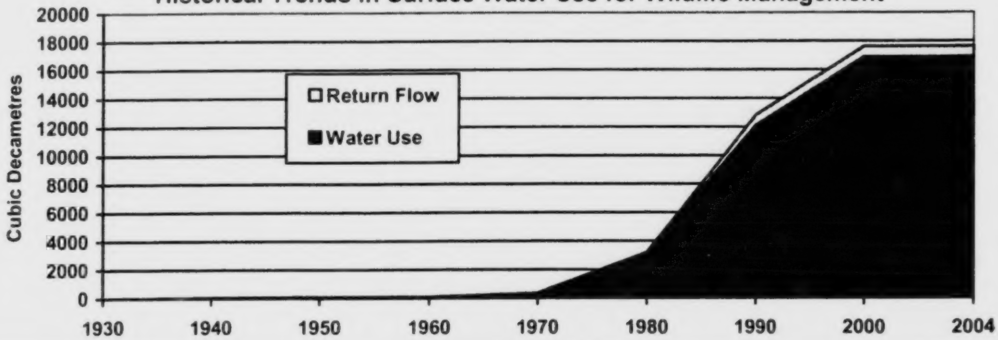


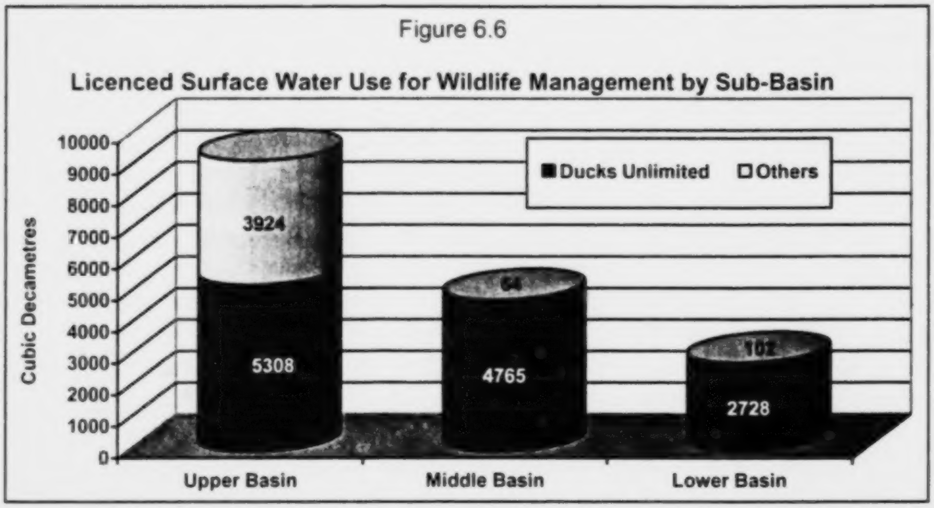
Table 6.4 and Figure 6.6 summarize the licences issued for wildlife management by sub-basin and licensee/operator.

Table 6.4

Summary of Surface Water Licences Issued for Wildlife Management

		Number of Licences	Allocation (dam³)	Water Use (dam³)	Return Flow (dam³)	Irrigation Hectares
Upper Basin	Other	7	3,924	3,924	0	0
	Ducks Unlimited	42	5,308	5,308	0	0
	Sub-total	49	9,232	9,232	0	0
Middle Basin	Other	2	64	64	0	0
	Ducks Unlimited	41	5,453	4,765	688	115
	Sub-total	43	5,517	4,829	688	115
Lower Basin	Other	6	102	102	0	0
	Ducks Unlimited	17	2,778	2,728	50	0
	Sub-total	23	2,880	2,830	50	0
Battle Basin	Other	15	4,091	4,090	0	0
	Ducks Unlimited	100	13,538	12,800	739	115
	Total	115	17,629	16,890	739	115

The table shows that 49 licences have been issued for the upper basin, allowing water use of 9,232 dam^3, of which Ducks Unlimited accounts for 57 per cent. In the middle basin, Ducks Unlimited manages or owns almost all the licences and 99 per cent of water use. In the lower basin, 96 per cent of licenced water use is associated with Ducks Unlimited projects. The table also shows that a small amount of water (four per cent) is returned to water bodies and the licences allow 119 hectares of backflood irrigation in the middle basin. Overall, licenced water use for Ducks Unlimited projects account for 12,800 dam^3; this represents 22 per cent of licenced surface water use in the BRB and is equivalent to 93 per cent of licenced water use by ATCO thermal power plant.



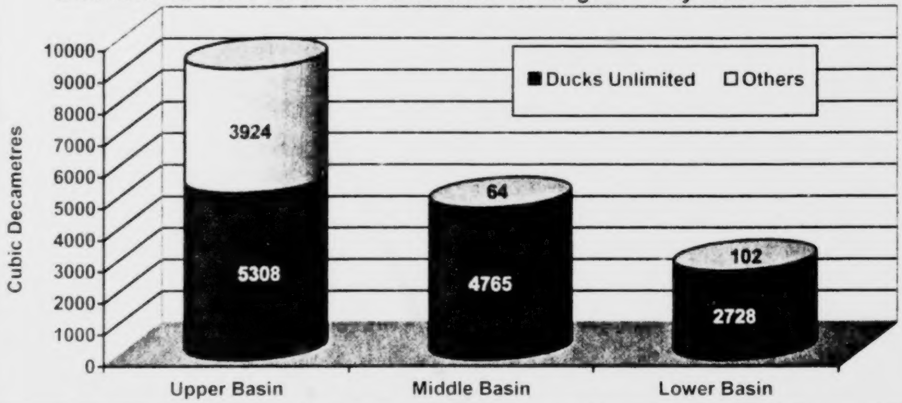
Ducks Unlimited provided information on water used by its projects in the BRB. Of the 100 licences, 30 were classified as stabilization projects with no return flow requirements. Ducks Unlimited provided water use data for 23 of these licences, representing 88 per cent of licenced allocations and determined that 92 per cent of their allocation was being used. The estimated water use for 23 stabilization licences was estimated to be 4,310 dam^3. The other 70 licences were for wetland projects, including three that are part of the Ribstone Creek Complex. Ducks Unlimited provided data for 46 of these licences representing 82 per cent of allocations. The data indicate that, for the sample of projects, Ducks Unlimited was using all of its entitlements. Thus, estimated water use for the wetland projects is estimated to be 7932 dam^3. Total water use by Ducks Unlimited in 2004 was therefore 12,242 dam^3, or 96 per cent of its licenced allocation.

There is no information on the actual amount of water used by the other 15 licences issued for wildlife management. However, it is assumed that these licences would be for projects that are similar to Ducks Unlimited projects, where usage depends on the amount of annual precipitation and surface run-off than can captured and held in small reservoirs or dugouts throughout the basin. Thus, water use would occur during March and April, and it is assumed that the water use would represent 100 per cent of the amount allowed in licences. It should be noted that estimates of natural flows in the BRB were developed assuming that all of the licence entitlements for wildlife purposes were utilized.

In total, it is estimated that 16,541 dam^3 of water were used for fisheries and wildlife management purposes in 2004. This includes the 209 dam^3 for fisheries management, 12,242 dam^3 for Ducks Unlimited, and 4,090 dam^3 for other wildlife management licences. It should be noted that, based on estimated use of 16,540 dam^3, fisheries and wildlife management represents the largest use of surface water in the basin, accounting for 37 per cent of all surface water use in the basin. While the volumes are very large compared to other uses, the allocation of water for wetland projects can be viewed as mitigation for the loss of natural wetlands as a results of agricultural development in the region. The prairie pothole region of which the BRB is a part, provides habitat for the production of approximately 50 per cent of North American

Figure 6.6

Licenced Surface Water Use for Wildlife Management by Sub-Basin



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In total, it is estimated that 16,541 dam^3 of water were used for fisheries and wildlife management purposes in 2004. This includes the 209 dam^3 for fisheries management, 12,242 dam^3 for Ducks Unlimited, and 4,090 dam^3 for other wildlife management licences. It should be noted that, based on estimated use of 16,540 dam^3, fisheries and wildlife management represents the largest use of surface water in the basin, accounting for 37 per cent of all surface water use in the basin. While the volumes are very large compared to other uses, the allocation of water for wetland projects can be viewed as mitigation for the loss of natural wetlands as a results of agricultural development in the region. The prairie pothole region of which the BRB is a part, provides habitat for the production of approximately 50 per cent of North American

waterfowl populations, and was identified as an areas of concern in the North American Waterfowl Management Plan

6.2.2 Future Conditions

It is unlikely that water use for fish and wildlife management projects in the BRB will change over the forecast period. Ducks Unlimited, which accounts for 74 per cent of water used for fish and wildlife management in the basin, has not developed any new wetland or stabilization projects in the basin since 1998. While it is still planning to develop new projects in the BRB, Ducks Unlimited indicated that its focus is to restore drained wetlands to pre-drainage or natural conditions that will not require additional allocations of water. It also noted that lake stabilization and backflood projects that would require additional water are not part of its present or future priorities. Ducks Unlimited also reported that, although there was a possibility some existing wetland projects might be discontinued, such projects would at most account for only one per cent of total water use. It also noted that it is not contemplating any operation changes that would changes its use of water. Thus, for estimating future water use, it is assumed that existing water use patterns will remain constant over the next 25 years.

6.3 Water Management Projects

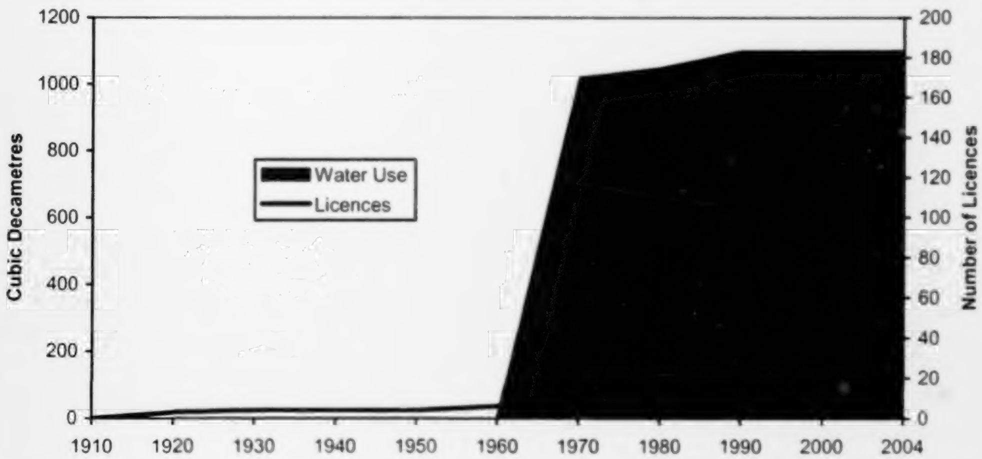
A small amount of water use is associated with a variety of water management projects throughout the BRB. These projects include licences to control flows of surface water and allow drainage of groundwater.

6.3.1 Existing Conditions

The issuance of licences for flood control commenced in 1910 but remained relatively unchanged until 1960. While the most rapid increase in the number of licences occurred during the 1980s, Figure 6.7 shows that most licenced water use was allocated in the 1960s.

Figure 6.7

Historical Trends in Surface Licences for Water Management - Flood Control



At present there are 180 licences for flood control. Many licences were issued so that water could be moved from one location to another, with no actual consumption. The records show that, for 169 of these 180 licences, neither an allocation nor a rate of diversion is specified, so there is no water use. Thus, water consumption is associated with only 11 licences.

Table 6.5 summarizes these 11 licences. It shows that total allocations amount to 1,557 dam^3 and a maximum of 1,101 dam^3 can be consumed. The table also indicates that most licences for flood control, where allocations were involved, were issued in the middle basin. However, the greatest water use associated with flood control (93 per cent) is one licence issued to Alberta Environment on Ribstone Creek in the lower basin. Most of the other licences were issued to municipal governments, but three licences were also issued to Luscar related to coal mining operations on a tributary to Paintearth Creek

Table 6.5

Summary of Surface Water Licences Issued for Flood Control

	Number of Licences	Allocation (dam^3)	Water Use (dam^3)	Return Flow (dam^3)
Upper Basin	1	51	51	0
Middle Basin	7	30	30	0
Lower Basin	3	1,476	1,020	456
Battle Basin	**11**	**1,557**	**1,101**	**456**

Water management licences have also been issued for drainage of groundwater. Five such licences have been issued and allow drainage of up to 482 dam^3 of water. Licenced consumption is only 21 dam^3, with most water (461 dam^3 or 96 per cent) being returned to a surface water body. Four licences were issued in the upper basin, primarily to municipal governments, and allow consumption of 13 dam^3. The other licence is for dewatering of a gravel operation in the middle basin. Three of these licences were issued after 1990 and they account for 40 per cent licenced water consumption.

There is no information on the actual amounts of water used for water management purposes in the BRB. For purposes of estimating water use it is estimated that the 100 per cent of the licenced entitlements are diverted and consumed each year.

6.3.2 Future Conditions

As shown in Figure 6.6 no new licences that allow water consumption for flood control purposes have been issued since 1990 and most were issued prior to 1980. With no recent changes in demand, it is assumed that current levels of surface water use will continue for the next 25 years.

Since drainage of groundwater currently accounts for only 0.3 per cent of total licenced groundwater use in the BRB, major changes would not substantially affect water use. Consequently, for purposes of predicting future water use, it has been assumed that current levels of use will remain unchanged for the next 25 years.

6.4 Other Uses

Five other water licences have been issued for various other purposes. One is for surface water and the other four are for groundwater. Total water use associated with these licences is only 32 dam^3, of which 30 dam^3 is for groundwater. Four licences are in the upper basin and one is in the middle basin. Since these uses account for less than 0.05 per cent of water use in the BRB, no further analysis or forecasts is warranted.

6.5 Summary

Table 6.6 summarizes existing and predicted future other water uses in the BRB. It shows that wildlife management accounts for the vast majority of these other water uses (86 per cent), with recreation and water management each accounting for about six per cent of the total. In the future, the use of surface water is expected to remain constant throughout the 25-year forecast period. Most groundwater uses are also not expected to change. The only exception is groundwater used for recreational purposes, where demands for more golf courses will result in small increases in future demand for the Base Case, High Growth and Low Growth scenarios. These increases in recreational demands will only change predicted water use for other purposes in 2030 by ±0.5 per cent over current levels.

Table 6.6

Forecast of Future Other Water Uses in the Battle River Basin (dam^3)

Base Case		**Licenced 2004**	**Actual 2004**	**Forecast 2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Surface	Recreation	1,444	1,195	1,195	1,195	1,195	1,195	1,195	1,195
	Wildlife Management	17,099	16,540	16,540	16,540	16,540	16,540	16,540	16,540
	Water Management	1,101	1,101	1,101	1,101	1,101	1,101	1,101	1,101
	Other	2	2	2	2	2	2	2	2
	Sub-total	19,646	18,838	18,838	18,838	18,838	18,838	18,838	18,838
Ground	Recreation	423	423	423	459	495	531	567	603
	Wildlife Management	0	0	0	0	0	0	0	0
	Water Management	21	21	21	21	21	21	21	21
	Other	30	30	30	30	30	30	30	30
	Sub-Total	474	474	474	510	546	582	618	654
	Total	**20,120**	**19,312**	**19,312**	**19,348**	**19,384**	**19,420**	**19,456**	**19,492**
High Growth	Surface			18,838	18,838	18,838	18,838	18,838	18,838
	Ground			474	528	582	636	690	744
	Total			19,312	19,366	19,420	19,474	19,528	19,582
Low Growth	Surface			18,838	18,838	18,838	18,838	18,838	18,838
	Ground			474	492	510	528	546	564
	Total			19,312	19,330	19,348	19,366	19,384	19,402

7 BASIN WATER USE PROJECTIONS

7.1 Surface Water

In 2004, 78 per cent of potential water use in the BRB allowed through licences and registrations was for surface water. Total allocations amounted to 751,815 dam^3 and, of this total, a maximum of 59,975 dam^3 could be consumed or lost through evaporation or seepage. However, data for 2004 shows that most licencees are not using their full allocations, and estimated water use was about 45,150 dam^3, or 75 per cent of licenced water use.

Sections 3 to 6 of this report have reviewed current water use practices for each of the major water use sectors, and have provided projections for three future growth scenarios. The assumptions used to develop projected surface water use are provided in Table 7.1

Table 7.1

Summary of Assumptions Use to Predict Annual Changes in Surface Water Use

Sector	Assumptions	Base Case	High Growth	Low Growth
Municipal Use	Water use is directly related to population growth	+0.8%	+1.2%	+0.6%
Stockwatering	Livestock populations in middle and lower basins will increase at historic rates but at half this rate for the upper basin.	+1.2%	+2.0%	+1.0%
Irrigation	No change from actual use in 2004	0.0%	0.0%	0.0%
Cooling (thermal power)	No change from actual use in 2004	0.0%	0.0%	0.0%
Oilfield Injection	Use will decline as oilfields age and production declines	-2.5%	0.0%	-5.0%
Other Industrial	Continuation of past trends will result in additional demands of 160 dam^3 per decade	+1.6%	+2.0%	+1.1%
Wildlife	No change from actual use in 2004	0.0%	0.0%	0.0%
Recreation	No change from actual use in 2004	0.0%	0.0%	0.0%
Water Management	No change from actual use in 2004	0.0%	0.0%	0.0%

Overall, the key sectors driving future use of surface water in the BRB are population growth in municipalities (particularly in the upper basin), expansion of livestock populations, and industrial growth other than thermal power production and oilfield injection. It should be noted that, in 2004, actual water use for oilfield injection amounted to only two per cent of existing allocation and this if forecast to continue to diminish over time. Water use in all other sectors is predicted to remain relatively constant over the next 25 years.

Based on the assumptions in Table 7.1, estimated future water use for the Base Case scenario is summarized in Table 7.2. The forecasts indicate that surface water use is expected to increase by 988 dam^3 (2.2 per cent) by 2010 and by 2,540 dam^3 (5.6 per cent) over the next 25 years. These increases appear relatively small, but this is because there is predicted to be no change in uses of water for irrigation, thermal power or wildlife, which collectively account for 80 per cent of actual water use in 2004.

Table 7.2

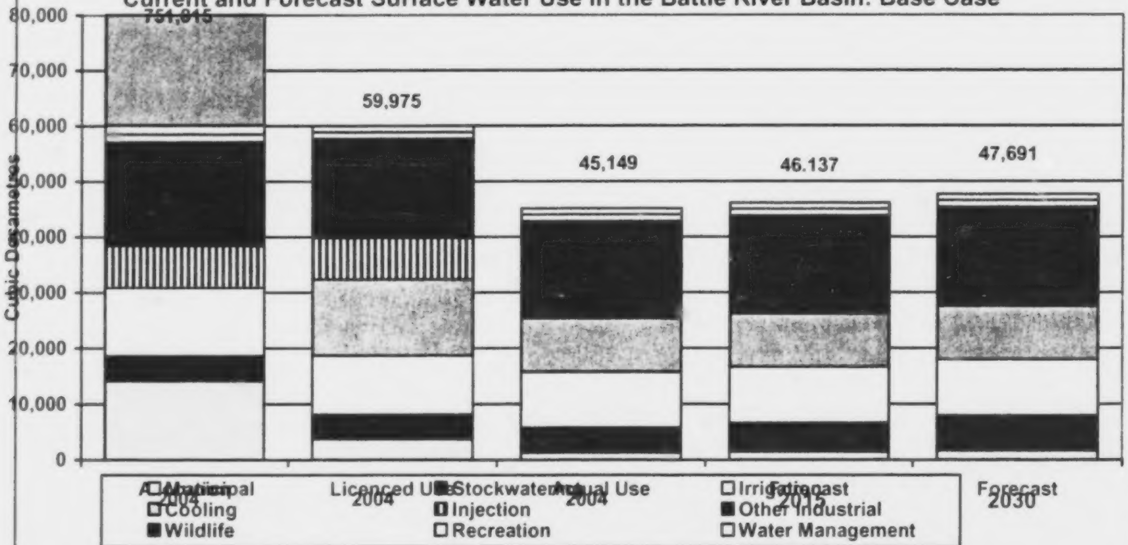
Current and Future Surface Water Use in the Battle River Basin: Base Case

	2004 Licences and Registrations		2004 Actual Use	Forecasts	
	Allocation	Water Use		2015	2030
Municipal	14,215	3,713	1,352	1,513	1,711
Stockwatering	4,432	4,432	4,432	5,135	6,288
Irrigation	12,216	10,508	9,960	9,960	9,960
Cooling	691,737	13,741	9,620	9,620	9,620
Injection	7,529	7,389	153	116	79
Other Industrial	844	794	794	955	1,195
Wildlife	17,838	17,100	16,540	16,540	16,540
Recreation	1,445	1,195	1,195	1,195	1,195
Water Management	1,559	1,103	1,103	1,103	1,103
TOTAL	**751,815**	**59,975**	**45,149**	**46,137**	**47,691**

The forecast of surface water under the Base Case scenario is provided graphically in Figure 7.1, which shows the relative unimportance of the municipal, stockwatering and other industrial sectors in regard to current and forecast surface water use. Figure 7.1 also shows that actual use in 2030 will only represent 80 per cent of current licenced water use. However, it is expected that some existing licences that are not currently being used will be cancelled, especially for oilfield injection, while new licences will be required for industrial growth and expansion of the livestock industry. Some additional municipal allocations may also be required.

Figure 7.1

Current and Forecast Surface Water Use in the Battle River Basin: Base Case



Under the High Growth scenario, actual water use would increase by 1,353 dam^3 or 3.0 per cent by 2015 and 3,557 dam^3 or 7.9 per cent by 2030. The Low Growth scenario would result in a 632 dam^3 increase (1.4 per cent) by 2015 and 1,645 dam^3 (3.6 per cent) by 2030. Thus, even

under the High Growth scenario, actual water use in 2030 would total 48,706 dam^3, which would still only represent 81 per cent of existing licenced surface water use.

These forecasts of surface water do not include surface water used for domestic purposes, which does not require a licence or reporting of water use. The forecasts also ignore the use of surface water imported into the BRB from other regions. At the present time about 1,183 dam^3 of water is imported from the Red Deer and North Saskatchewan river basins for municipal water use. About 232 dam^3 is actually consumed or lost, and the balance is treated and returned to surface water bodies in the BRB. This will increase when Lacombe and Ponoka start using water from the City of Red Deer in 2005 and when Donalda, Red Willow and other rural parts of Stettler County eventually start using water from an expanded Stettler regional system. As shown in Table 7.3, use of imported water will increase to 899 dam^3 in 2005, 954 dam^3 by 2015 and 1,051 dam^3 by 2030. Inclusion of imported water would result in two per cent increase in predicted use of surface water un the BRB by 2030.

Table 7.3

Forecast of Imported Surface Water Use in the Battle River Basin

	2001	2005	2015	2030
Base Case	232	899	954	1,051
High Growth			993	1,161
Low Growth			933	994

7.2 Groundwater

About 22 per cent of water use authorized through existing licences and registrations issued in the BRB was for groundwater. In 2004, total allocations of groundwater amounted to 21,845 dam^3, of which consumption and losses could account for a maximum of 17,681 dam^3. Licences and registrations specify that the balance (4,164 dam^3) be returned to surface water bodies in the basin. Estimates of actual use suggest that actual water use accounted for 73 per cent of allowable water use; thus, 27 per cent of allowable water use is not being utilized. This proportion was similar to the utilization factor for surface water allocations.

Table 7.4 summarizes the assumptions used to predict future groundwater use in the BRB, based on the information provided in Sections 3 to 6. The table shows that the most significant percentage increases in future use of groundwater will be for stockwatering, other industrial use and recreation. Small increases are predicted for municipal use, while water use for oilfield injection is expected to significantly decline over the next 25 years. No changes are predicted for use of groundwater for irrigation, thermal power, or water management.

Table 7.4

Summary of Assumptions Use to Predict Annual Changes in Groundwater Use

Sector	Assumptions	Base Case	High Growth	Low Growth
Municipal Use	Water use is directly related to population growth	+0.2%	+0.6%	-0.1%
Stockwatering	Livestock populations in middle and lower basins will increase at historic rates but at half this rate for the upper basin.	+1.2%	+2.0%	+1.0%
Irrigation	No change from actual use in 2004	0.0%	0.0%	0.0%
Cooling (thermal power)	No change from actual use in 2004	0.0%	0.0%	0.0%
Oilfield Injection	Use will decline as oilfields age and production declines	-2.5%	0.0%	-5.0%
Other Industrial	Continuation of past trends will result in additional demands of 140 dam^3 per decade	+1.6%	+2.0%	+1.1%
Recreation	Future increases tied to expansion of golf courses of 36 dam^3 every five years	+1.4%	+1.9%	+0.7%.
Water Management	No change from actual use in 2004	0.0%	0.0%	0.0%

Table 7.5 presents the groundwater use forecasts for the Base Case scenario, based on the assumptions noted in Table 7.4. The forecast for 2015 shows only a modest increase in groundwater use above current levels. An increase of only 923 dam^3 (seven per cent) is predicted, but this reflects a significant reduction in municipal groundwater use (642 dam^3) when Lacombe and Ponoka switch to imported water. A much more significant increase in groundwater use is predicted between 2015 and 2030. During this period, groundwater use is forecast to increase by 2,520 dam^3 (18 per cent). This represents a 27 per cent increase over current groundwater use.

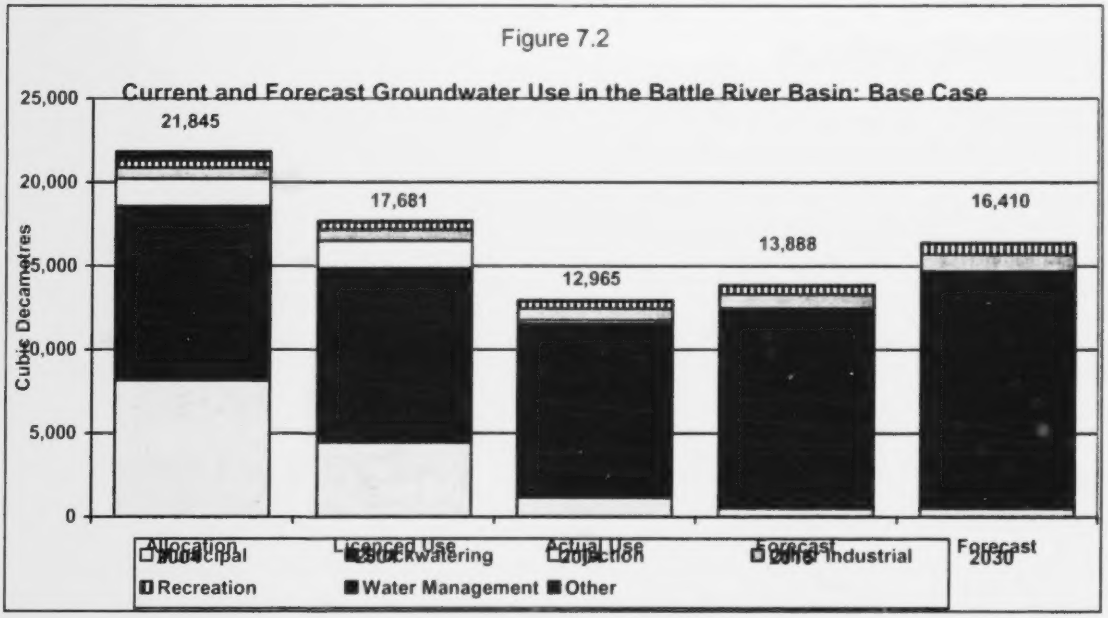
Table 7.5

Current and Future Groundwater Use in the Battle River Basin

	2004 Licences and Registrations		2004 Actual Use	Forecasts	
	Allocation	Water Use		2015	2030
Municipal	8,153	4,457	1,161	529	539
Stockwatering	10,420	10,420	10,420	11,812	14,047
Irrigation	27	27	27	27	27
Cooling	5	5	5	5	5
Injection	1,611	1,611	191	145	99
Other Industrial	694	688	688	830	1,040
Wildlife	0	0	0	0	0
Recreation	423	423	423	495	603
Water Management	512	50	50	50	50
TOTAL	**21,845**	**17,681**	**12,965**	**13,888**	**16,410**

The forecast shows that the greatest increase in groundwater use will be for stockwatering. Stockwater use currently accounts for 80 per cent of all groundwater so any growth in this sector will cause a significant increase in total groundwater use. Over the 25-year forecast period, stockwater use of groundwater is predicted to increase by 3,627 dam^3. In comparison, increased groundwater use by the recreation and other industrial sectors will only increase by 532 dam^3. Use of groundwater for oilfield injection is forecast to decline by 92 dam^3.

Figure 7.2 shows how the pattern of groundwater use will change over time. The significance of groundwater use for stockwatering is evident. The forecasts show that, by 2030, actual groundwater use will amount to nearly 93 per cent of currently licenced groundwater use. It is expected that some current groundwater allocations than are no longer be used will be cancelled and some new licences for stockwatering, other industrial and recreational purposes will be issued. Some additional groundwater licences for municipalities will also be required, especially in the upper and lower basins where population growth is expected.



Use of groundwater under the High Growth scenario would see total use reach 14,581 dam^3 by 2015 and 18,187 dam^3 by 2030. These volumes are 12.5 per cent and 40.3 per cent higher than current levels. Estimated use under the Low Growth Scenario would result in a 263 dam^3 increase (2.0 per cent) by 2015 and 1,757 dam^3 (13.6 per cent) by 2030. Under the High Growth scenario, predicted water use in 2030 would exceed current allocations by about three per cent.

7.3 Total

The overall water use forecast for the BRB is provided in Figure 7.3 and combines surface water and groundwater use. Of the 773,660 dam^3 allocated, approved consumption and losses can amount to 77,656 dam^3. Actual water use in 2004 is estimated to be 58,114 dam^3, which amounts to 75 per cent of maximum licenced water use.

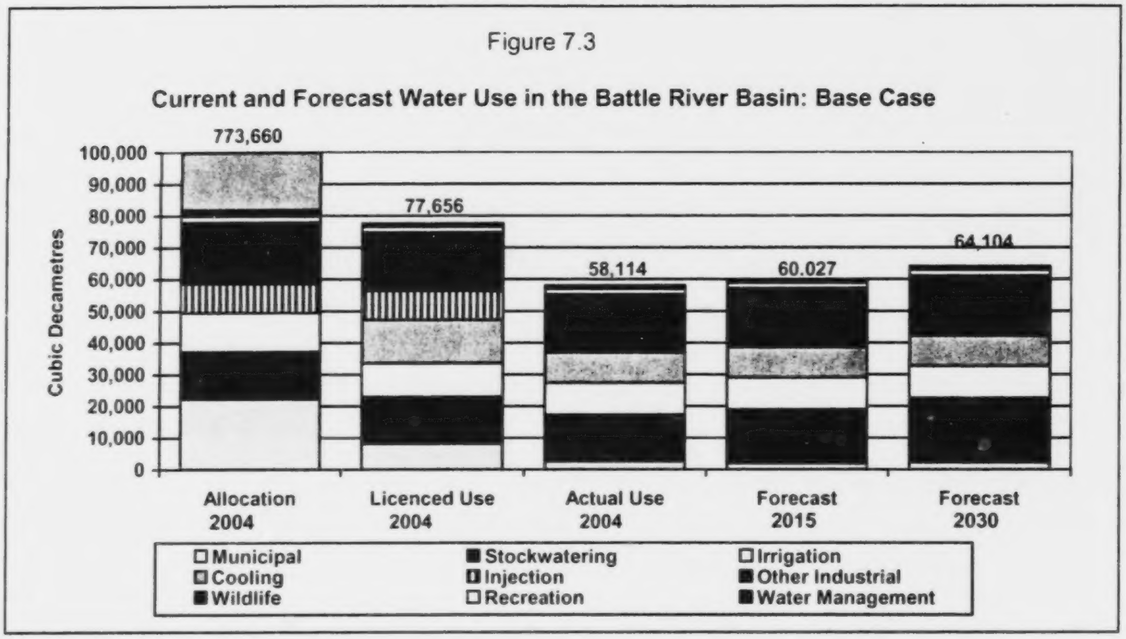
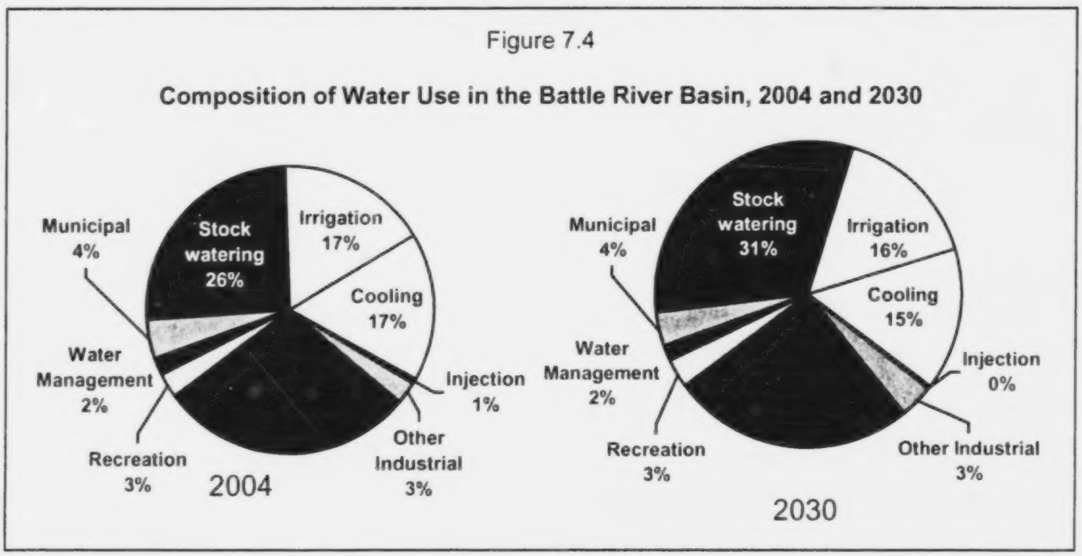


Figure 7.3 shows that water use is predicted to increase to about 60,000 dam^3 by 2015 and 64,100 dam^3 by 2030. Expansion of the livestock industry is expected to result in the greatest overall increase in water use. Increased water use in the other sectors is hardly noticeable.

Figure 7.4 compares water use profiles between 2004 and 2030. It shows that, by 2030, stockwatering will overtake wildlife as the most significant water use in the BRB, accounting for 31 per cent of water use. While there will be a small increase in the percentage of water used by municipalities, this component will still only account for four per cent of water use in the basin.

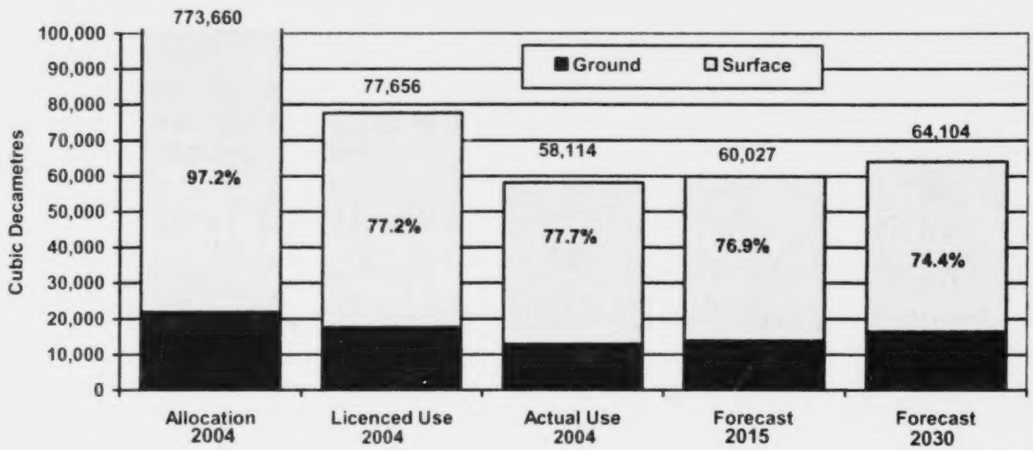


Since the amount of water used for irrigation, cooling and wildlife is not predicted to change over time, their share of water use will decrease slightly over time. Water used for oilfield injection will further decline, accounting for only 0.3 per cent of total use by 2030. The proportion of total water use for the other sectors will remain constant over time.

Figure 7.5 shows the current split between surface water and groundwater and how this is predicted to change over time. It shows that, although 97 per cent of existing allocations are for surface water, groundwater can account for about 23 per cent of licenced water use. While actual water use in 2004 was less than the licenced amount, 23 per cent of that use was groundwater. Over time, groundwater will account for an increasing percentage of total water use. This use is not apparent until 2030, however, because there will be a significant reduction in groundwater use in 2005 when Lacombe and Ponoka switch to imported surface water. By 2030, groundwater is expected to account for nearly 26 per cent of water use in the BRB.

Figure 7.5

Forecast Surface Water and Groundwater Use in the Battle River Basin



8 WATER SUPPLY ALTERNATIVES

To accommodate growing demands for water use in the BRB, water users are expected to investigate and employ appropriate water conservation strategies and to seek alternatives source of water. Two possible sources of additional water are the North Saskatchewan River and the Red Deer River. Some options for diverting water from these sources have already been proposed and described below.

8.1 Diversions from the North Saskatchewan River Basin

A number of proposals have been made to augment flows in the BRB with water from the North Saskatchewan River. Some were first considered in the mid-1980s and these are now being re-examined. While the *Water Act* prohibits inter-basin transfers of water, the Battle River is considered to be a sub-basin of the North Saskatchewan River.

8.1.1 Option 1: Esso Pipeline Supply Augmentation

Imperial Oil Resources Ltd. (Esso) currently withdraws water from the North Saskatchewan River for injection to enhance oil recovery from the Wizard Lake oil field. In 1992 it constructed a pumphouse and about 19 km of pipe to provide untreated water to an injection battery. The Village of Thorsby also draws raw water from this system. Esso has two licenses for a combined volume of 6,955 dam^3 while the Village has its own licence for 250 dam^3. With Esso completing its water flood of the Wizard Lake reservoir in 2003, an assessment of this pipeline system was conducted to determine whether it could be modified to supply water to the BRB. This assessment was completed in 2003 by Techna-West Engineering Ltd.[38]

8.2.1.1 <u>Description</u>

Techna-West investigated extending the pipeline system by about 18.2 km and discharging water in Pipestone Creek. Operating with one pump would supply water at a rate of 0.14 m^3/s; adding a second pump could increase the flow to 0.18 m^3/s. The total cost of this alternative was determined to be $12 million (2003$), with annual operating costs of $0.25 million. The report noted that, if the system is not extended, a small pump would be needed to serve the Village of Thorsby.

8.2.1.2 <u>Communities/Area Affected</u>

Augmentation of flows in Pipestone Creek could benefit all downstream users on Pipestone Creek and on the mainstem of the Battle River. Current total water consumption in these reaches during the spring and summer typically ranges between 0.91 and 2.11 m^3/s, although peak consumption of 6.03 m^3/s occurs in April.

8.2.1.3 <u>Water Demand</u>

Data for Pipestone Creek near Wetaskiwin show that average monthly flows are highest in April (3.8 m^3/s) and then drop until July when average flows are in the range of 1.3 m^3/s. Flows in the Pipestone then gradually decline during the rest of the summer and fall; the average flow for September is only 0.05 m^3/s. Water use in the Pipestone sub-basin averages about 0.05 m^3/s for April through September. Thus, piped water from the North Saskatchewan River would be

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[38] Techna-West Engineering Ltd. (2003) *Alberta Environment Battle River Basin Water Supply Scope of Work.*

adequate to provide nearly triple the existing demands in the Pipestone sub-basin. Flows of 0.14 m^3/s would also be equivalent to between seven and 15 per cent of water consumption in the Pipestone and downstream reaches of the Battle River.

8.2.1.4 Implications for the Battle River Basin

Techna-West concluded that the small volumes of water provided by operating the existing pipeline system would cause no appreciable change in flows in Pipestone Creek.

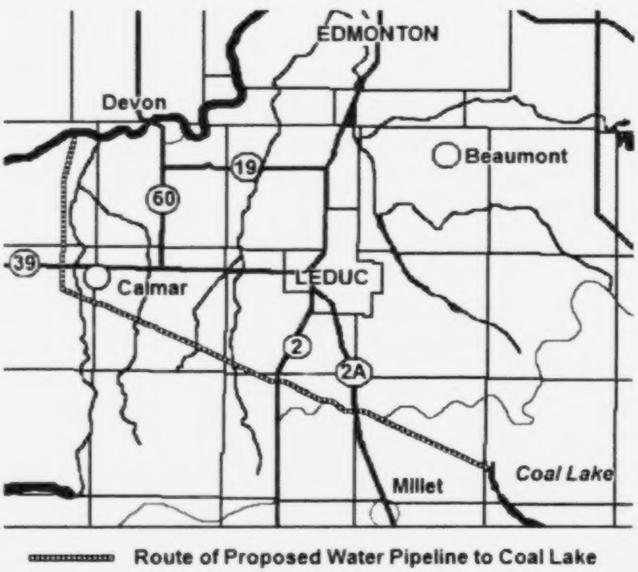
However, it noted that, with one pump, the pipeline could be used to deliver 0.096 m^3/s to a specific user at a maximum distance of 100 km, including the City of Camrose. A second pump could allow 0.128 m^3/s to be supplied to a specific user at a maximum distance of 75 km.

8.1.2 Option 2: New Pumphouse and Pipeline

The possibility of constructing a pumphouse and pipeline was first assessed in 1986. Alberta Environment prepared a preliminary engineering report that examined three alternative routes and provided cost estimates. One of these routes, as shown in Figure8.1, was re-examined by Techna-West in 2003.

Figure 8.1

Proposed Pipeline Route For Diverting Water from the North Saskatchewan River in the Battle Basin



8.1.2.1 Description

The project evaluated by Techna-West involved construction of an intake structure on the North Saskatchewan River, and low lift pump and sedimentation pond, a high life pump station, 44 kilometres of one-metre diameter steel pipe, and an outfall at Coal Lake. Cost estimates were developed for facilities that would pump at rates of 2 m^3/s, 3 m^3/s, and 6 m^3/s. This system

would have at least 14 times the capacity of Esso's existing pipeline and pumphouse. The larger facilities would cost between $91 million (2003$) and $186 million. Annual pumping costs would range between $2.2 million and $5.7 million.

8.1.2.2 Communities/Area Affected

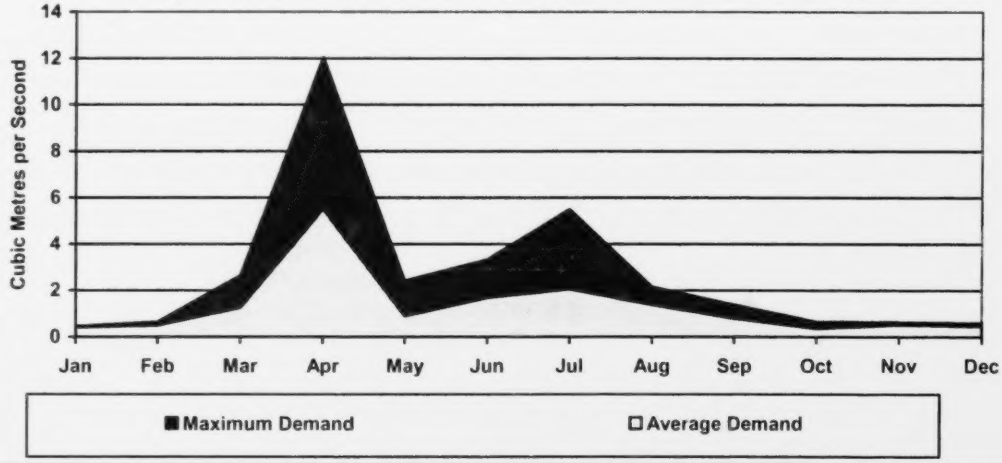
Water imported directly into Coal Lake could be used to supply consumers on all downstream reaches of the Battle River. Water consumers in the basin above Gwynne or in the Pipestone or Bigstone sub-basins would not benefit directly from such a scheme, but some restrictions due to downstream commitments could be reduced, thereby providing the opportunity for additional allocations in the upstream reaches.

8.1.2.3 Water Demand

Average and maximum water use since 1984 in the two mainstem reaches below Coal Lake is shown in Figure 8.2. This figure shows that water consumption during average spring and summer condition ranges from 0.89 to 2.07 m^3/s, with peak demand in April being 5.50 m^3/s. Maximum demands in June and July were 3.34 and 5.50 m^3/s, respectively, while demand in April reached 12.05 m^3/s.

Figure 8.2

Average and Maximum Water Consumption Downstream of Coal Lake



Thus, a pipeline providing 2 m^3/s could supply nearly all existing uses during an average year, except for peak demand in April, but there would be little capacity to meet additional demands in dry years. With a flow of 3 m^3/s, a pipeline would satisfy all existing demands in an average year plus most existing demands under dry conditions observed over the last 20 years. At 6 m^3/s, a pipeline would satisfy normal and peak demands in an average year, most demands in a dry year, and provide considerable extra capacity for most months of the year.

8.1.2.4 Implications for the Battle River Basin

Using a pipeline to divert water from the North Saskatchewan River into the BRB at Coal Lake could dramatically reduce demands on natural flows in the BRB. A supplemental flow of 2 m^3/s would satisfy all existing surface water users in the lower reaches of the basin in an average year,

thereby allowing the Battle to revert to near natural flow conditions in most months. Alternatively, the additional flow could accommodate some additional demand for the summer months. Increasing the rate of pumping would provide even more capacity for accommodating future demand. However, current peak demands in dry years would require most of the proposed capacity.

8.1.3 Other Options

The North East Alberta Water Management Coalition (NEAWMC) was formed in December 2003 to "supply water to our membership, i.e. farming community, business, industry, towns, urban centres, by developing the infrastructure to get the water delivered".[39] Coalition members include Camrose County, Beaver County, Lamont County, County of Minburn, County of Two Hills, the Municipal District of Bonnyville, and CU Water Limited..

NEAWMC would like to build on the success of CU Water's Highway 14 Regional Water System which pipes treated water from Sherwood Park to Viking and distributes water to various other users. CU Water is evaluating water demand and supply options for most of the BRB and part of the lower North Saskatchewan River Basin. NEAWMC believes that the North Saskatchewan River is the best source of raw water in the region.

NEAWMC believes that a regional water supply system offers important advantages because it would replace a number of individual water treatment plants with one central plant and an automated distribution system to provide treated water. It contends that a regional system would cost less than replacing existing treatment facilities and would be less expensive to operate. A study of possible regional water supply alternatives is currently underway.

8.2 Diversions from the Red Deer River Basin

Water is being diverted from the Red Deer River to communities in East-Central Alberta through the Henry Kroeger Regional Water Supply system, which was completed in 1988. It draws Red Deer River water to a treatment facility in Hanna and then distributes treated water to communities along Highway 9 in Starland County and Special Areas #2 and #3, south of the BRB.

In October 2004 the City of Red Deer signed an agreement with the recently-established North Red Deer River Water Services Commission. Under the terms of the agreement, the City of Red Deer will provide treated water to the Commission which will then distribute water to the Towns of Blackfalds, Lacombe, and Ponoka and portions of Lacombe and Ponoka Counties. This system could commence operations as soon as September 2005 and will cost approximately $22 to $24 million. In accordance with the requirements of the *Water Act*, in December of 2002 the Alberta Government passed the *North Red Deer Water Authorization Act* so that water could be transferred from the Red Deer River basin into the North Saskatchewan River Basin, and specifically the BRB.

Several other proposals for regional water supply systems are also being considered. However, their approval would also require an authorization for an inter-basin transfer of water.

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[39] North East Alberta Water Management Coalition (2004). Information Sheet dated June 15, 2004.

8.2.1 Stettler Regional Distribution System

Communities located along Highway 12 in the County of Paintearth and Special Area #4 are currently experiencing some problems with their water supplies. Highway 12 approximates the southern edge of the BRB. As shown in Table 8.1, most communities rely on poor quality groundwater that does not meet the Canadian Drinking Water Quality Guidelines, while future supply reliability is an issue for Castor, Coronation and possibly Halkirk.

Table 8.1

Status of Water Supplies for Municipal Users Along Highway 12

Community	Source	Adequacy of Supply	Water Quality	Daily Use (litres/person)	Proposed Actions
Castor	Parr Reservoir	Unreliable	Deteriorating	424	New well (or) Raw water from Stettler
Coronation	Groundwater	Inadequate	Poor	470	Drill new well Reverse osmosis treatment Expand treated storage Expand lagoon
Consort	Groundwater	Reliable	Poor	499	Reverse osmosis treatment
Veteran	Groundwater	Reliable	Poor	457	Upgrade treatment system
Halkirk	Groundwater	Reliable (?)	Poor	262	Secure existing well Upgrade treatment system Expand treated storage
County of Paintearth	Groundwater	Unreliable	Poor	450	
Special Area #4	Groundwater	Reliable	Poor	450	

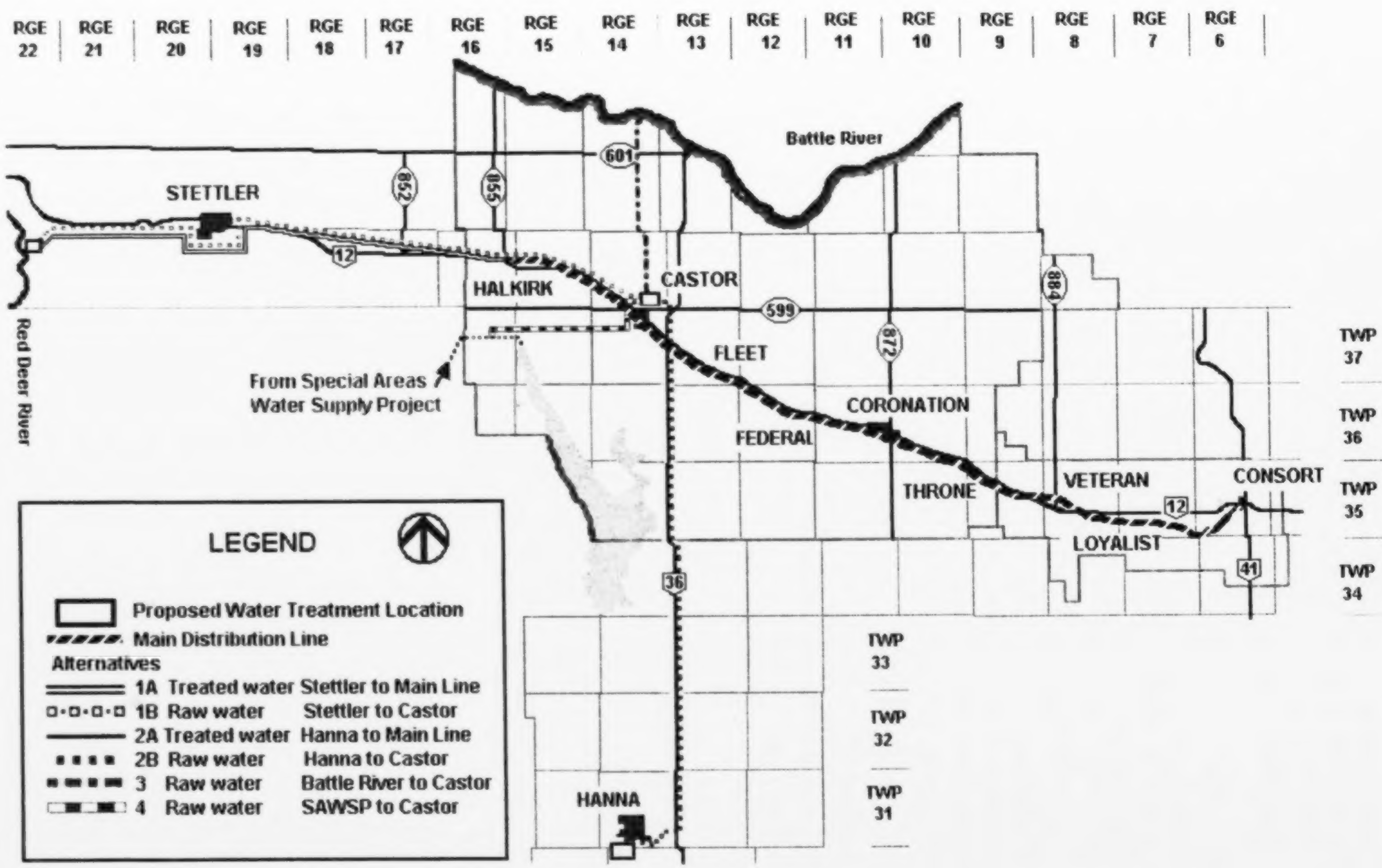
A study of possible alternatives for addressing these issues was completed in 2004 by MPE Engineering Ltd. for the County of Paintearth and Special Area #4. MPE determined that the cost of addressing problems for individual communities would be quite high ($22.6 million) and would offer no relief to the rural populations in either SA #4 or the County of Paintearth. MPE also examined several regional water supply systems and determined that these would provide a more cost-effective solution for resolving municipal and domestic water supply concerns along Highway 12.

8.2.1.1 Description

MPE Engineering Ltd. examined various sources of raw water, including five aquifers, the Battle River, Sullivan Lake, Parr Reservoir (Castor), and the Red Deer River either through the existing Stettler water system or through SAWSP. It also examined various means of providing treated water to the region, including water from the HKRWC, the Stettler water treatment plant, and the Town of Castor water treatment plant. In assessing possible options, MPE used a design flow of 3820 litres (840 gallons) per minute based on estimated regional population for 2024 and rural agricultural demands. MPE determined that no existing water supply system had sufficient capacity to meet an additional demand of 3820 litres (840 gallons) per minute so upgrading of raw water storage, treated water storage, water treatment facilities and/or pumping capacity would be required.

Figure 8.3

Proposed Regional Red Deer River Water System Alternatives



Source: MPE Engineering Ltd.

Table 8.2

Proposed Regional Water System Alternatives

Option	Raw Water Source	Treatment Facility	Service Area	Design Features	Pipeline Length	Cost	Comments
1A	Red Deer River	Stettler Water Treatment Plant	Highway 12 Stettler County of Stettler	Raw water reservoir (Red Deer River) Upgrade Stettler treatment plant Booster and pressure relief station Treated water reservoir/distribution centre Pressure reducing/monitoring stations (2)	149 kms	$39.6 million	Costs to SA 4 & County of Paintearth would be $25.7 million
1B	Red Deer River	Castor Water Treatment Plant	Highway 12	Pump station on Red Deer River Upgrade Castor treatment plant Upgrade Castor treated water storage Pressure reducing/monitoring station	191 kms	$31.7 million	Interbasin transfer of raw water may not be approved
2A	Henry Kroeger Regional Water Commission	Henry Kroeger Regional Water Commission	Highway 12 Highway 36	Expand existing raw water reservoir Raw water storage reservoir (Hanna) Upgrade HKRWC treatment plant Upgrade HKRWC treated storage Upgrade HKRWC distribution pumps	173 kms	$36.7 million	Environmental concerns along Highway 36
2B	Henry Kroeger Regional Water Commission	Castor Water Treatment Plant	Highway 12	Upgrade existing raw water reservoir Upgrade Sheerness pumping station Raw water storage reservoir (Hanna)	173 kms	$34.0 million	Interbasin transfer of raw water may not be approved
3	Battle River	Castor Water Treatment Plant	Highway 12	New raw water intake and pump station Booster station Increase Parr Reservoir capacity Upgrade Castor water treatment plant Upgrade Castor treated water storage Upgrade Castor distribution pumps	130 kms	$33.1 million	Water may not be available from Battle River or only available five months of the year Environmental concerns.
4	Special Areas Water Supply Project	Castor Water Treatment Plant	Highway 12	Raw water intake and pump station (Sullivan Lake) Expand Castor water treatment plant.	126 kms	$22.2 million	Lowest cost alternative. Requires interbasin transfer.

Source: MPE Engineering Ltd.

MPE evaluated seven different options for regional water supply, including the option of upgrading existing treatment facilities for each of the individual towns and villages, as described in Table 20. These options are described in Table 8.2 and Figure 8.3.

Options 1A and 1B would draw water from the Red Deer River at the existing facility near Stettler. Under Option 1A, this water would be treated at an upgraded Stettler water treatment plant and distributed to communities along Highway 12 as well as the Town of Stettler and Stettler County. This option would be cost shared with the other beneficiaries and the share for residents of SA #4 and Paintearth County would be about $25.7 million. Under Option 1B, raw water would be pumped to the Castor water treatment plant and treated water would then be distributed to communities along Highway 12. This alternative is more expensive ($31.7 million) and the interbasin transfer of raw water from the Red Deer River to the Battle River may not be allowed under the *Water Act*.

Options 2A and 2B would bring water from the HKRWC into the region. Option 2A calls for water to be treated at the existing water treatment plant at Hanna and then pumped north along Highway 36 and on to communities along Highway 12. Upgrades to the HKRWC system would be required to handle the additional demands and this would result in the highest cost of all the alternatives ($36.7 million). Option 2B would be less expensive ($34.0 million) and would see raw water from the HLRWC system piped to the Castor water treatment plant. Treated water would then be distributed to users along Highway 12. However, this option represents an inter-basin transfer and it may be difficult to receive regulatory approval for this option.

Option 3 would require the construction of a new diversion and pumping station on the Battle River and raw water would be piped to the Castor water treatment plant. Treated water would then be piped to communities along Highway 12. This option is relatively expensive ($33.1 million) and may not be feasible because MPE considered the Battle River to be over-allocated and would not provide a reliable year-round source of water. It estimated that pumping from the Battle River might only be possible for five months of the year and this would require construction of a large raw water storage reservoir with capacity for seven months of demand.

Option 4 calls for water to be withdrawn from SAWSP at Sullivan Lake and piped to the Castor water treatment plant, only 21 kilometres away. Treated water would then be provided to the communities along Highway 12. This option has the lowest cost of al the options ($22.2 million) but this would be in addition to the cost of constructing SAWSP ($192.3 million).

Based on its review of these options, MPE concluded that Option 4, taking water from SAWSP, represents the most feasible alternative from a cost perspective, but cautioned that this is based on timely approval and construction of SAWSP.

8.2.1.2 Communities/Area Affected

All of the regional supply alternatives considered by MPE would affect communities in the Battle River Basin. These communities include Castor, Coronation, Veteran and Halkirk, plus rural populations and two Hutterite colonies. Based on 2001 Census numbers, these regional supply alternatives would provide reliable flows of treated water to a population of about 5,565

people or about 5.1 per cent of basin residents. This amounts to about 90 per cent of all the potential beneficiaries of the proposed regional water system.

8.2.1.3 Water Demand

In assessing possible options, MPE used a design flow of 3820 litres (840 gallons) per minute. This design flow assumed that urban and regional populations would increase by about one per cent per year, average daily water use ranges between 100 and 110 gallons (455 to 500 litres) per person, and peak demand was 2.0 to 2.25 times greater than average daily demand. Using actual historical water use (see Table 8.1), this suggests annual water demands of about 791 dam^3 for the 2001 population in the BRB and 981 dam^3 for the projected population in 2024.

8.2.1.4 Implications for the Battle River Basin

For most of the proposed alternative regional water supply alternatives there would be minimal implications for the BRB because the importation of water from the Red Deer River basin would primarily replace poor quality groundwater. Only Castor is currently drawing surface water; it is licensed to withdraw 246.7 dam^3 from Castor Creek, with annual consumption and losses amounting to 80.2 dam^3. In 2003 Castor reported providing 145 dam^3 of treated water to community residents.

Option 3 would place additional significant demands on the Battle River. Under this option, annual withdrawals would be expected to increase by between 650 dam^3 per year under current demands and by 800 dam^3 by 2024 if demands increase as predicted. However, as noted in Table 8.1, the most significant problem with this option was that sufficient water may not be available from the Battle River on a year-round basis.

8.2.2 Special Areas Water Supply Project[40]

The Special Areas in east-central Alberta is an agricultural area that was hard hit by the droughts of the 1920s and 1930s. This prompted many regional residents to migrate elsewhere and, as a result of variable precipitation and agricultural conditions since then, the regional population has continued to decline, dropping to 11,300 in 2001. The outlook for the region is for continued decline as young adults and families leave the region. The development of a reliable supply of high quality water is seen as the key for future economic development in the Special Areas. In the 1980s, completion of the Sheerness pipeline provided Red Deer River water for thermal power production, some irrigation, and to communities along Highway 9 via the Henry Kroeger Regional Water Supply System. However, many communities and most farms remain without adequate supplies of water.

It is important to note that an assured supply of high quality water is important for regional economic and social stability. Census data show that the population decline for communities drawing water from the Henry Kroeger Regional Water Supply System was only 1.9 per cent between 1996 and 2001 while communities like Consort, Empress and Veteran, which rely on other water sources, experienced a 15.4 per cent decline.

[40] The description of the Special Areas Water Supply Project is drawn from Watrecon Consulting (2005). *Socio-Economic Assessment of the Special Areas Water Supply Project.* Prepared for the Special Areas Board.

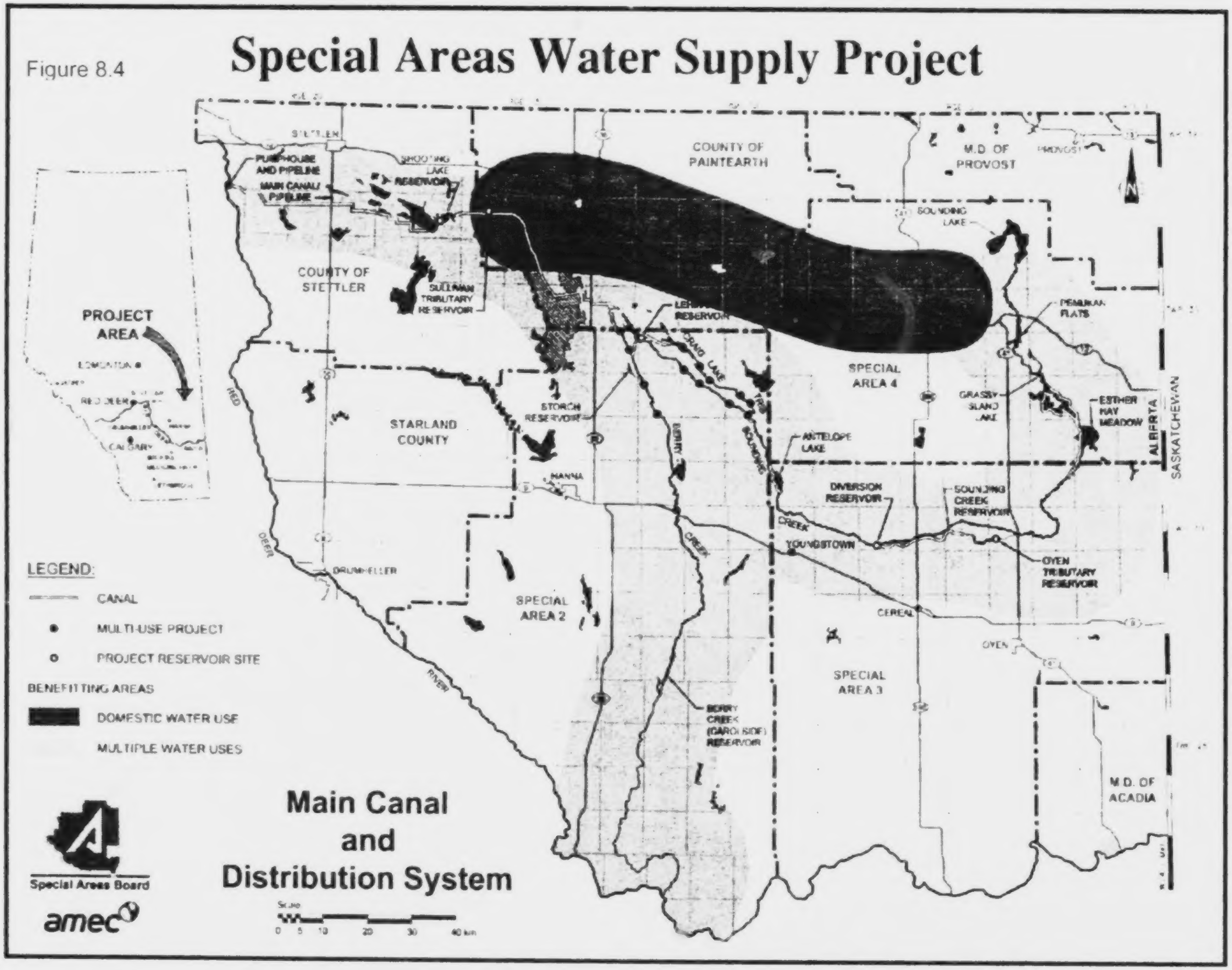
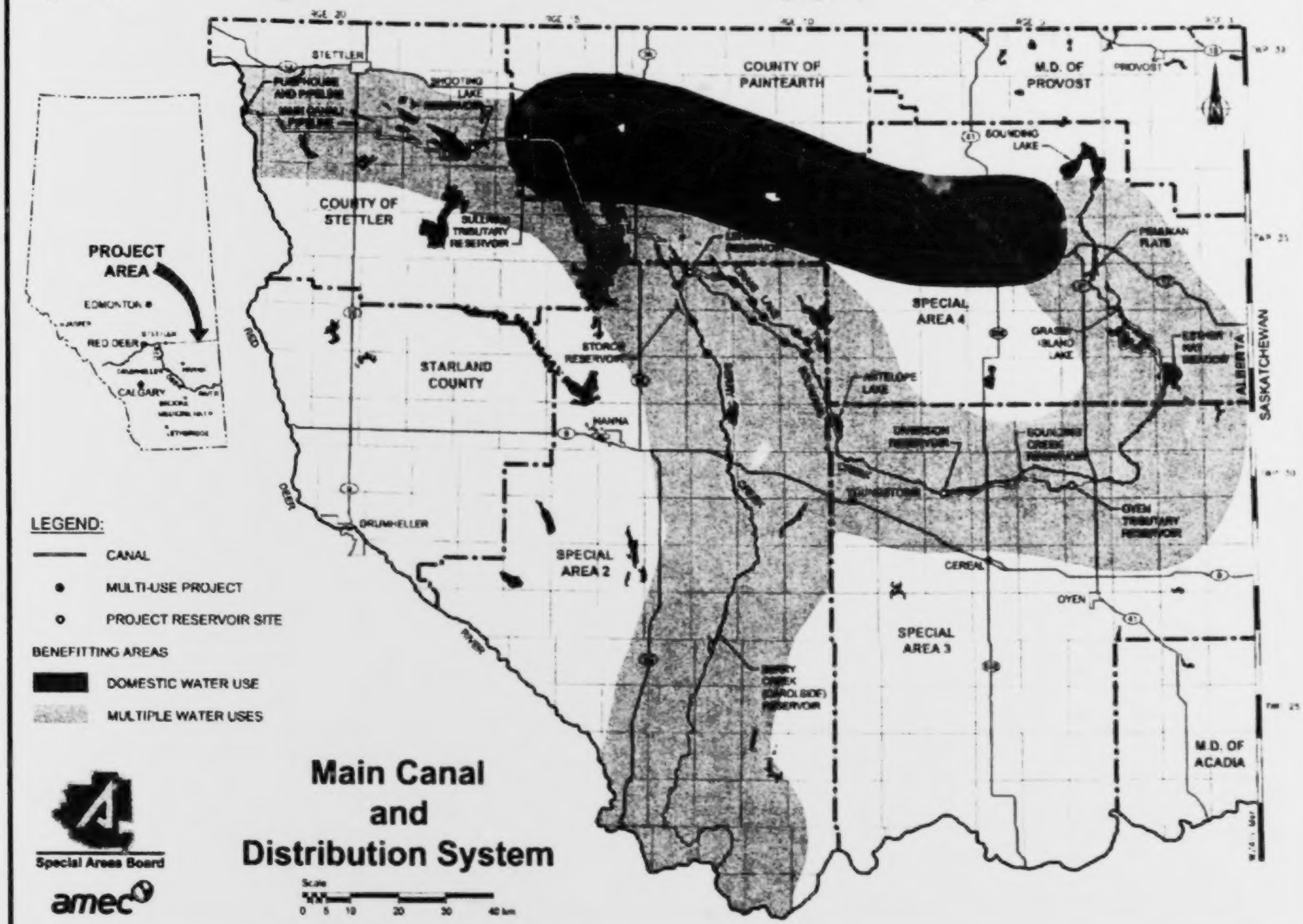


Figure 8.4
Special Areas Water Supply Project
STETTLER
PUMPHOUSE AND PIPELINE
MAIN CANAL/ PIPELINE
SHOOTING LAKE RESERVOIR
COUNTY OF PAINTEARTH
M.D. OF PROVOST
PROVOST
SOUNDING LAKE
COUNTY OF STETTLER
SULLIVAN TRIBUTARY RESERVOIR
PROJECT AREA
EDMONTON
RED DEER
CALGARY
PEMMICAN FLATS
SPECIAL AREA 4
GRASSY ISLAND LAKE
ESTHER HAY MEADOW
ALBERTA
SASKATCHEWAN
STARLAND COUNTY
STORCH RESERVOIR
ANTELOPE LAKE
HANNA
DIVERSION RESERVOIR
SOUNDING CREEK RESERVOIR
YOUNGSTOWN
OYEN TRIBUTARY RESERVOIR
DRUMHELLER
RED DEER RIVER
BERRY CREEK
SPECIAL AREA 2
CEREAL
OYEN
LEGEND:
CANAL
MULTI-USE PROJECT
PROJECT RESERVOIR SITE
BENEFITTING AREAS
DOMESTIC WATER USE
MULTIPLE WATER USES
SPECIAL AREA 3
BERRY CREEK (CAROUSIDE) RESERVOIR
M.D. OF ACADIA
Main Canal and Distribution System
Special Areas Board
amec
Scale
0 5 10 20 30 40 km

Figure 8.4

Special Areas Water Supply Project



8.2.2.1 Description

The Special Areas Water Supply Project) SAWSP) would withdraw water from the Red Deer River near Nevis by way of a pump station capable of diverting up to 7.08 cubic metres of water per second during the 150-day period from mid-April to the end of October. Water would be pumped out of the valley through a 4.5-km pressurized pipeline. The main canal or pipeline would be 84 km in length and would convey water to the headwaters of Berry and Sounding creeks. There would be about 44,250 dam^3 of live storage along the main canal at Shooting Lake (2,000 dam^3), Sullivan Lake Tributary Reservoir (4,000 dam^3), Lehman Reservoir (24,000 dam^3), and Oyen Reservoir (14,250 dam^3). A water distribution system consisting of 507 km (314 mi) of live stream (canals and natural channels) would be constructed.

At a cost of $192.3 million, the project would provide 20,000 acres of new irrigation, allow backflood irrigation on 5,780 acres, stabilize 14 existing wetlands and create two new ones, provide more reliable stockwatering in more of the region, and enhance domestic and municipal water supplies. However, enhancement of the domestic and municipal supplies is contingent on spending an additional $22.2 million to construct a treated water pipeline to serve communities along Highway 12, as described in Section 8.2.1.

8.2.2.2 Communities/Area Affected

SAWSP would enhance municipal water supplies in Castor, Coronation, Veteran and Halkirk, plus rural populations and two Hutterite colonies. This represents about 5,565 people or about 5.1 per cent of basin residents.

SAWSP would also allow increased agricultural production by increasing forage production in support of raising cattle and by providing better stockwatering and grazing in areas adjacent to the canals and natural channels. SAWSP would benefit numerous species of waterfowl, upland birds, big game, plus nine species at risk by creating two new wetlands, enhancing 14 existing wetlands and providing 5780 acres of backflood irrigation. This is estimated to increase hunting activity by about 19,000 hunter-days and attract an additional 19,000 days of activity by bird watchers and other non-consumptive users of wildlife, thereby increasing tourism activity in the region.

Overall SAWSP would increase regional employment by between 65 and 90 person-years, and the regional population would increase by between 140 and 190 people. Regional incomes would increase by $8.7 to $9.8 million, and would help stabilize the regional economy and population.

8.2.2.3 Water Demand

Based on the regional water system proposed by MPE and described in Section 8.2.1.3, SAWSP would meet annual water demands of about 791 dam^3 for the 2001 population in the BRB and 981 dam^3 for the projected population in 2024.

8.2.2.4 Implications for the Battle River Basin

Implications for the BRB would be minimal because, with the exception of the Town of Castor, the importation of water from the Red Deer River basin would primarily replace poor quality groundwater. As noted in 8.2.1.4, SAWSP would displace only about 145 dam^3 of surface water from a tributary to the Battle River.

9 OPTIONS FOR WATER CONSERVATION AND IMPROVEMENTS IN WATER USE EFFICIENCY

In 2003 the Alberta Government released the *Water for Life* strategy, which sets out its intent to develop a new water management approach and strategies to address the increasing pressures on its finite water resources. One of the long-term goals of the strategy is to improve the overall efficiency and productivity of water use in Alberta by 30 per cent between 2005 and 2015. To attain this goal, the Alberta Government supports improving water use practices through significant conservation efforts.

This section of the report identifies options for water conservation and improved water use efficiency for each of the major water use sectors in the BRB. This work is based largely on a recent study of non-storage options for meeting increasing demands for water in the Highwood River basin.[41] The Highwood study represents the first detailed assessment of water conservation and efficiency options in Alberta and, although the mix of water use in the Highwood basin differs somewhat from the BRB, the options for conservation are applicable in the BRB and throughout the rest of Alberta.

9.1 Municipal Water Use

Overall, municipal water use accounts for a very small proportion of total water use in the basin (three per cent of surface water use). Nevertheless, there are various ways in which municipalities can use water more efficiently, and this can result in lower costs to consumers as well as reduced demands on surface and groundwater. The Highwood study identified the options for improving municipal water use efficiency identified in Table 9.1.

Table 9.1

Options for Municipal Water Use Efficiency Improvements

Measure	Potential Water Saving
Education/awareness	4%
Universal water metering	11% to 27%
Appliance retrofits (toilets, shower heads)	5% to 30%
Water system audits (leak detection)	6%

Overall, the Highwood study estimated that the combination of these four measures could reduce municipal water use by 35 per cent. The study also noted that adoption of "realistic" water pricing could also substantially reduce water use, noting that a 20 per cent increase in water rates would reduce municipal water use by an additional six per cent.

While adoption of these municipal water efficiency measures in the BRB would result in reduced water use, the potential savings are impossible to determine without a better understanding of current municipal water use practices by communities in the basin. Such an analysis is beyond the scope of this analysis. However, given the relatively small amounts for water used for municipal purposes in the BRB, major efficiency improvements would have a relatively minimal impact on total water use in the basin, but could be locally significant.

[41] AMEC Earth & Environmental (2001). *Non-Storage Options Assessments Highwood Management Plan Phase 1*. Prepared for Alberta Environment.

Table 9.2

Comparison of Livestock Watering Systems

Livestock watering practice	Impact on water source and livestock	Cost factor (1999 prices)
Direct access	5-10% loss in water storage/year deterioration in water quality Animal health and production concerns Environmental concerns along streams, etc.	Dugout construction costs High dugout maintenance – $150 - 300/year
Restricted access ramp	Marginal loss in water storage Reduced water quality, animal health and production concerns	$500 to fence and construct ramp Moderate dugout maintenance costs – $100/year $.75/ft2 without geotextile; $1.00/ft2 with geotextile
Water hauling **Gravity-fed**	Same comments as for pipeline No loss in water storage No negative effect on water quality, animal health and production concerns	System and hauling cost System cost Low maintenance costs for dugouts/dam – $50/year
Pumped gravity flow reservoirs (built on top of the excavated spoil piles)	Slight increase in water storage No negative effect on water quality, animal health and production	$2,500 - $3,000 to fence, construct and line the reservoir, plus purchase a 5-hp gas pump, 500 gallon stock tank, water pipe and install a cement pad around the tank
Animal operated pasture pumps	No loss in water storage No negative effect on water quality, animal health and production Two-day training period for livestock to learn pump operation Cattle water consumption is significantly less in winter than in summer. In winter, the pump will be able to handle twice as many animals as in the summer	$700 to fence and purchase pump ($450 ea.) maximum of 30 - 40 cow-calf pairs/pump Low maintenance costs for dugout and pump $50/year Frost free nose pumps will cost $2000 to $2500 to purchase and install (pump is approximately $1000)
Pipeline	No negative effect on water quality, animal health and production	$.50 - $1.00 per lined foot Pipe can be buried shallow for summer pasture and drained in the fall Allows the use of neighbouring sources of water wells, dugouts, etc
Solar pumping systems	Slight increase in water storage No negative effect on water quality, animal health or production	$3,000 - $6,000 to fence and install the solar pump, solar panels, optional battery, water storage stock tank and cement pad Capacity of 50 - 400 cow-calf pairs
Windmills	Slight increase in water storage No negative effect on water quality, animal health or production Some air-operated pumps actually improve dugout water quality by aeration Must pump the water storage full during extended periods of calm weather	$2,000 - $2,500 to set up Koenders windmill and air-operated pump, plus a 1200 gallon plastic water tank, 500 gallon stock tank, cement pad and pipe Capacity (at approx. 10 ft lift) for 50 cow-calf pairs in central Alberta, up to 100 cow-calf pairs in windy southern Alberta $3,500 - $4,000 to fence and set up Dutch Industries – Delta Junior windmill, plus 1,200 gallon plastic water tank, 500 gallon stock tank and water pipe Capacity (at approx. 10 ft lift) is estimated to be 200 cow-calf pairs in central Alberta and 400 cow-calf pairs in southern Alberta Moderate maintenance of dugout and system $100 - $150/year

Note: Dugout maintenance will mainly involve chemical control of plant algae plus excavation costs for cleaning dugouts where direct access occurs.

9.2 *Agricultural Water Use*

9.2.1 Stockwatering

Stockwatering in the BRB accounts for a small portion of current surface water use in the BRB (10 per cent), but is by far the largest user of groundwater (80 per cent of total groundwater use). Consequently, improvements in stockwatering practices could have a significant impact on annual water use in the BRB.

In the Highwood basin study, it was concluded that more information was required to understand why water demand based livestock populations was so much larger than licenced allocations before appropriate water conservation measures could be identified.[42] However, the study identified two opportunities for improved stockwatering. One of these was improved surface water management. The study suggested that enhancing riparian landscapes and limiting direct livestock to riparian flows, as advocated by the Cows and Fish program, can trap sediments, improve aquifer recharge, and reduce the frequency, duration and severity of low flow conditions. The second opportunity was improved/enhanced management of off-stream dugouts. It was suggested that pumping water from dugouts to watering troughs combined with fencing would prevent livestock from having direct access to dug-outs, leading to better quality water and improved weight-gain of up to 25 per cent. The Highwood study concluded that improved stockwatering management practices could improve water use efficiency by about 10 per cent.

Alberta Agriculture, Food and Rural Development has identified a number of options for improved stockwatering.[43] These are listed in Table 9.2. It notes that just precluding livestock from direct access to dugouts or surface water sources would prevent losses of five to 10 per cent. Recent innovations, such as animal operated pasture pumps, can substantially reduce losses in the winter.

There is no information on the mix of stockwatering practices currently being used in the BRB, so it is not possible to assess the extent to which the stockwatering efficiency could be improved. Given the significance of stockwatering use in the BRB, possible efficiency improvements could significantly reduce water use.

9.2.2 Irrigation

The Highwood basin study explored various options for improving irrigation efficiency. These included changing the irrigated crop mix in favour of crops that use less water, adopting more efficiency water application technology, and changing how farmers manage the use of their irrigation equipment. The Highwood study found that shifting to barley silage could reduce irrigation water use by 10 per cent and increased use of water efficient technology (more low pressure centre pivots) could reduce water use by three per cent.

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42 At the time that the Highwood study was completed the amount of water being used by traditional agricultural users (i.e. registrations) was unknown and would likely have accounted for much of the difference.

43 As reported at http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex644?opendocument.

Unfortunately very little is known about private irrigation practices in the BRB, even though this use currently accounts for about 22 per cent of surface water use. The water licence data suggest that most irrigation is backflood irrigation on relatively small areas to raise forage for livestock. Thus, there are limited opportunities for technology improvements or changes in crop mixes. It is likely that irrigation technology is being used for some portion of irrigated lands, but both the technology used and the portion of lands being actively irrigated are not known. As shown in Table 9.3, some considerable improvements in irrigation water use efficiency are possible if, for example, hand move sprinklers are replaced by low-pressure centre pivot systems. Table 4.10 shows the relative costs of these irrigation technologies.

Table 9.3

Water Use Efficiency of Alternative Irrigation Technologies

Irrigation Method		Efficiency Range
Gravity	Undeveloped	20% to 45%
	Developed	50% to 85%
Sprinkler	Hand move and solid set	55% to 85%
	2-wheel lateral	65% to 80%
	4-wheel lateral	65% to 80%
	High pressure pivot, linear	70% to 85%
	Low pressure pivot, linear	75% to 95%

It is recommended that a more detailed assessment of irrigation practices in the BRB be undertaken in order to gain a better understanding of current water use and to assess the opportunities for water use efficiency.

9.3 Industrial Water Use

Industrial water use, specifically water used for cooling (thermal power) and oilfield injection, accounts for a significant amount of surface and groundwater use in the BRB. However, opportunities for substantial efficiency improvements are limited. Information on ATCO's thermal power plant shows that, because of water recycling, water consumption and losses account for only two per cent of the licenced allocation. ATCO also indicated that not significant changes in water use technology are currently being contemplated at the plant. With respect to oilfield injection, data show that water use has declined substantially over time as the oil reserves are depleted and this trend is expected to continue. In addition, the data show that the energy industry is using a significant amount of saline water for enhanced oil recovery and this has also reduced use of potable water.

The Highwood study identified increased recycling and use of industrial water pricing as having the greatest potential for improving water use efficiency. While pricing might create an incentive for further reductions in the amount of potable water for oilfield injection, ATCO's use of water would likely not be affected because it is tied directly to power production. Additional study would be required to determine the extent to which industrial water pricing would affect water use for oilfield injection and other industrial purposes.

APPENDICIES

APPENDIX A:

Methodology for Basin Population Estimates

Population estimates for the Battle River Basin (BRB) developed using information from the 2001 Census. The urban population for cities, towns, villages, summer villages and Reserves were taken directly from the 2001 Census. The rural populations had to be estimated, however, because the basin boundaries do not coincide with county or census subdivision boundaries.

The rural populations were estimated using the assumption that rural residents are evenly distributed throughout each municipality. Thus, the proportion of county rural residents residing in the BRB is assumed to be the same of the proportion of the land base for each county that falls within the BRB. This approach was also used by Stanley Associates in its 1985 assessment of water use in the Battle Basin.

The proportion of each county and municipal district falling within the BRB was provided by Alberta Environment. The rural population of the BRB was then estimated using the 2001 Census data, as shown below:

Census Division	Counties and Municipal Districts	Per Cent in Battle Basin	Rural Population 2001 Census	Estimated Rural Population
4	Special Area 4	6.2%	1,514	94
7	Provost No. 52	53.3%	2,635	1,404
	Paintearth County	65.8%	2,192	1,442
	Stettler County	36.8%	5,357	1,971
	Flagstaff County	99.3%	3,697	3,671
	Wainwright No. 61	92.6%	4,231	3,918
8	Ponoka County	52.4%	8,875	4,638
	Lacombe county	12.4%	10,159	1,260
10	Camrose County	82.3%	7,294	6,003
	Beaver County	28.0%	5,644	1,580
	Minburn County	10.3%	3,436	354
	Vermilion River County	39.3%	7,524	2,957
11	Wetaskiwin County	66.2%	10,695	7,080
	Leduc County	11.3%	12,528	14,16
		TOTAL	85,781	37,789

This same approach was used to estimate regional socio-economic and agricultural characteristics. The following tables summarize 2001 Census information for the BRB.

Table A.1

Age Characteristics of Battle River Basin Residents

	Lower Basin			Middle Basin			Upper Basin			Battle River Basin			ALBERTA
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Age 0-4	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	5.6%	5.4%	5.6%	5.8%	5.8%	5.8%	6.3%
Age 5-14	14.6%	16.5%	15.6%	13.0%	17.6%	14.8%	14.7%	16.5%	15.3%	14.3%	16.8%	15.2%	14.5%
Age 15-19	7.0%	9.4%	8.3%	7.3%	9.2%	8.0%	7.4%	8.8%	7.8%	7.3%	9.0%	7.9%	7.5%
Age 20-24	6.3%	6.6%	6.5%	5.7%	4.4%	5.2%	6.1%	4.3%	5.6%	6.0%	4.8%	5.6%	7.2%
Age 25-44	29.9%	29.2%	29.6%	25.8%	26.4%	26.1%	26.7%	26.2%	26.5%	26.8%	26.8%	26.8%	31.9%
Age 45-54	12.8%	14.7%	13.8%	12.0%	15.6%	13.4%	12.6%	16.1%	13.7%	12.5%	15.7%	13.6%	14.1%
Age 55-64	8.0%	8.2%	8.1%	8.9%	10.1%	9.4%	9.1%	11.8%	10.0%	9.0%	10.6%	9.6%	8.1%
Age 65-74	7.0%	5.7%	6.3%	9.3%	6.7%	8.3%	8.4%	7.3%	8.0%	8.4%	6.8%	7.9%	5.8%
Age 75-84	6.1%	3.0%	4.5%	8.0%	3.3%	6.2%	6.7%	3.0%	5.6%	6.9%	3.1%	5.6%	3.4%
Age 85 and over	2.5%	0.6%	1.5%	3.7%	0.6%	2.5%	2.6%	0.6%	2.0%	2.8%	0.6%	2.0%	1.1%
Ages 65+	15.5%	9.3%	12.2%	21.0%	10.6%	16.9%	17.6%	11.0%	15.6%	18.2%	10.5%	15.5%	10.4%

Table A.2

Marital Characteristics of Battle River Basin Residents

	Lower Basin			Middle Basin			Upper Basin			Battle River Basin			ALBERTA
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Common-law Status													
Not in a common-law relationship	91.5%	94.9%	93.3%	93.5%	95.3%	94.2%	92.8%	94.7%	93.4%	92.9%	94.9%	93.6%	92.2%
In a common-law relationship	8.5%	5.1%	6.7%	6.4%	4.8%	5.8%	7.1%	5.3%	6.6%	7.1%	5.1%	6.4%	7.8%
Legal Marital Status													
Single	28.2%	28.6%	28.4%	24.8%	24.5%	24.7%	26.9%	24.1%	26.1%	26.6%	25.1%	26.0%	32.7%
Married	52.7%	61.8%	57.5%	54.9%	66.1%	59.1%	52.4%	64.6%	56.1%	53.0%	64.5%	57.0%	51.9%
Separated	2.9%	1.6%	2.3%	2.4%	1.3%	1.9%	3.1%	1.9%	2.8%	2.9%	1.7%	2.5%	2.9%
Divorced	7.6%	4.6%	6.0%	6.7%	4.3%	5.8%	8.4%	5.7%	7.5%	7.9%	5.1%	6.9%	7.6%
Widowed	9.1%	3.4%	6.1%	11.3%	3.8%	8.5%	9.1%	3.7%	7.5%	9.6%	3.7%	7.6%	5.0%

Table A.3

Mobility Characteristics of Battle River Basin Residents

	Lower Basin			Middle Basin			Upper Basin			Battle River Basin			ALBERTA
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Mobility Status - Place of Residence 1 Year Ago													
Lived at the same address 1 year ago	80.2%	89.8%	85.3%	86.4%	94.6%	89.7%	81.4%	92.3%	84.8%	82.5%	92.4%	86.1%	82.4%
Lived within the same province or territory 1 year ago, but changed address	15.8%	5.5%	10.3%	11.9%	4.3%	8.8%	16.4%	6.5%	13.3%	15.4%	5.7%	11.8%	14.4%
Lived in a different province/territory or country 1 year ago	4.1%	4.7%	4.4%	1.7%	1.2%	1.5%	2.1%	1.2%	1.8%	2.2%	1.9%	2.1%	3.3%
Mobility Status - Place of Residence 5 Years Ago (Total population 5 years and over)													
Lived at the same address 5 years ago	47.3%	71.0%	60.0%	60.8%	80.1%	68.5%	48.6%	74.1%	56.5%	51.3%	75.1%	59.9%	50.8%
Lived within the same province/territory 5 years ago, but changed address	39.4%	20.2%	29.1%	33.2%	16.9%	26.6%	43.0%	22.0%	36.4%	40.4%	20.3%	33.1%	37.5%
Lived in a different province/territory or country 5 years ago	13.5%	8.8%	11.0%	6.1%	3.0%	4.9%	5.6%	2.8%	4.7%	6.5%	4.0%	5.6%	11.7%
Immigration Characteristics													
Canadian-born population	94.8%	96.7%	95.8%	95.7%	96.2%	95.9%	93.1%	93.0%	93.1%	93.8%	94.6%	94.1%	84.5%
Foreign-born population	4.9%	2.9%	3.9%	4.2%	3.7%	4.0%	6.8%	6.8%	6.8%	6.0%	5.2%	5.7%	14.9%
Immigrated before 1991	80.6%	83.1%	81.7%	86.7%	82.7%	85.2%	79.7%	74.7%	78.1%	80.9%	77.1%	79.6%	70.4%
Immigrated between 1991 and 2001	14.5%	14.1%	14.3%	8.6%	16.0%	11.4%	20.6%	25.1%	22.0%	18.2%	22.2%	19.5%	29.6%
Non-permanent residents	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.2%	0.1%	0.2%	0.2%	0.1%	0.2%	0.6%
Aboriginal Population													
Aboriginal identity population	1.5%	2.0%	1.8%	1.7%	1.0%	1.4%	4.3%	2.8%	3.8%	3.4%	2.1%	3.0%	5.3%
Non-Aboriginal population	98.4%	98.0%	98.2%	98.6%	99.1%	98.8%	95.7%	97.2%	96.2%	96.6%	97.9%	97.1%	94.7%

Table A.4

Labour Force Characteristics of Battle River Basin Residents

	Lower Basin			Middle Basin			Upper Basin			Battle River Basin			ALBERTA
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Industry - Experienced labour force													
Agriculture and other resource-based industries	15.4%	44.5%	32.0%	20.5%	52.5%	34.4%	7.3%	36.5%	17.3%	11.1%	42.4%	23.5%	10.9%
Manufacturing and construction industries	8.9%	9.2%	9.1%	10.5%	7.0%	9.0%	14.6%	13.5%	14.2%	13.1%	10.9%	12.2%	15.8%
Wholesale and retail trade	12.8%	9.3%	10.8%	18.1%	8.3%	13.8%	18.5%	12.2%	16.3%	17.9%	10.6%	15.0%	15.4%
Finance and real estate	4.5%	2.1%	3.1%	4.2%	2.1%	3.3%	4.6%	2.5%	3.8%	4.5%	2.3%	3.6%	5.0%
Health and education	17.7%	9.3%	12.9%	16.8%	10.4%	14.0%	23.4%	12.6%	19.7%	21.3%	11.4%	17.4%	15.4%
Business services	13.1%	7.3%	9.8%	13.5%	9.7%	11.9%	12.5%	11.3%	12.1%	12.8%	10.1%	11.7%	18.8%
Other services	27.9%	18.4%	22.5%	17.1%	9.8%	13.9%	19.6%	11.4%	16.8%	19.8%	12.3%	16.8%	18.7%
Occupation - Experienced labour force													
Management occupations	9.4%	7.0%	8.0%	11.7%	4.2%	8.4%	10.1%	6.5%	8.9%	10.4%	6.0%	8.7%	10.5%
Business, finance and administration occupations	14.5%	11.4%	12.7%	13.0%	11.0%	12.2%	15.4%	12.6%	14.4%	14.7%	11.9%	13.6%	17.3%
Natural and applied sciences and related occupations	2.9%	2.1%	2.4%	2.7%	2.0%	2.4%	3.3%	2.3%	2.9%	3.1%	2.2%	2.7%	7.0%
Health occupations	4.5%	2.6%	3.4%	5.2%	4.7%	5.0%	7.7%	4.3%	6.5%	6.8%	4.1%	5.7%	4.9%
Social science, education, government service and religion	7.7%	3.6%	5.4%	5.6%	2.8%	4.4%	8.2%	4.3%	6.8%	7.5%	3.8%	6.0%	7.0%
Art, culture, recreation and sport	1.8%	0.6%	1.1%	1.3%	0.7%	1.0%	1.7%	1.7%	1.7%	1.6%	1.2%	1.5%	2.2%
Sales and service occupations	27.0%	19.9%	23.0%	25.1%	13.5%	20.0%	26.4%	14.5%	22.3%	26.1%	15.3%	21.8%	23.5%
Trades, transport and equipment operators and related occupations	18.9%	12.6%	15.3%	20.5%	13.1%	17.3%	18.2%	18.1%	18.2%	18.8%	15.7%	17.6%	16.8%
Occupations unique to primary industry	9.4%	38.5%	26.0%	10.9%	44.9%	25.7%	5.6%	32.7%	14.9%	7.2%	37.1%	19.1%	6.9%
Occupations unique to processing, manufacturing and utilities	3.8%	2.0%	2.7%	3.5%	3.0%	3.3%	3.5%	3.3%	3.4%	3.5%	3.0%	3.3%	3.9%

Table A.5

Employment Force Characteristics of Battle River Basin Residents

	Lower Basin			Middle Basin			Upper Basin			Battle River Basin			ALBERTA
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Participation rate	67.6%	79.1%	73.6%	62.3%	80.1%	69.1%	66.0%	71.3%	67.6%	65.3%	75.1%	68.7%	73.1
Employment rate	65.0%	78.0%	71.6%	59.7%	77.8%	66.6%	62.2%	66.9%	63.6%	61.9%	71.9%	65.4%	69.3
Unemployment Rate	3.7%	1.5%	2.5%	4.2%	2.8%	3.7%	5.8%	6.2%	5.9%	5.2%	4.3%	4.9%	5.2

Table A.6

Employment Earnings Characteristics of Battle River Basin Residents

	Lower Basin			Middle Basin			Upper Basin			Battle River Basin			ALBERTA
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Persons 15 years of age and over with income	4695	5287	9982	9,740	7,240	16,980	33905	15266	49171	48,340	27,792	76,132	2266520
Composition of total income (100%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100
Earnings - % of income	77.1%	79.0%	78.1%	71.8%	78.6%	74.7%	73.8%	77.7%	75.0%	73.7%	78.2%	75.3%	81.1
Government transfers - % of income	13.4%	10.7%	11.9%	16.6%	12.2%	14.7%	15.5%	12.8%	14.7%	15.5%	12.2%	14.3%	9.3
Other money - % of income	9.4%	10.2%	9.8%	11.6%	9.3%	10.6%	10.7%	9.5%	10.3%	10.8%	9.6%	10.3%	9.5

Table A.7

Household Characteristics of Battle River Basin Residents

	Lower Basin			Middle Basin			Upper Basin			Battle River Basin			ALBERTA
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Total - All private households													
Households containing a couple (married or common-law) with children	31.3%	43.1%	36.9%	31.0%	41.3%	35.9%	28.0%	37.7%	31.8%	29.0%	39.6%	33.6%	32.6%
Households containing a couple (married or common-law) without children	28.7%	33.6%	31.0%	35.6%	37.1%	36.2%	31.5%	38.0%	32.7%	32.1%	37.0%	33.1%	27.9%
One-person households	31.4%	15.5%	23.9%	37.3%	16.3%	30.8%	28.9%	16.1%	24.2%	31.0%	16.1%	25.6%	23.1%
Other household types	10.9%	7.6%	9.4%	10.7%	5.3%	7.8%	14.4%	8.0%	12.6%	13.3%	7.3%	11.0%	16.3%

Table A.8

Housing Characteristics of Battle River Basin Residents

	Lower Basin			Middle Basin			Upper Basin			Battle River Basin			ALBERTA
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Number of rented dwellings	715	277	992	1,455	291	1,746	5665	764	6429	7,835	1,332	9,167	316645
Average gross monthly payments for rented dwellings ($)	571	1406	1459	1,805	2,097	1,998	2374	2533	2882	4,751	6,036	6,339	674
Number of owner-occupied dwellings	1910	1169	3079	5,040	1,437	6,477	12640	3965	16605	19,590	6,571	26,161	736065
Average monthly payments for owner-occupied dwellings ($)	1096	1852	1841	3,128	2,892	3,253	3479	3510	3588	7,703	8,254	8,682	875
Selected Occupied Private Dwelling Characteristics													
Total number of dwellings	2635	2296	4931	6,505	3,393	9,898	18285	7107	25392	27,425	12,795	40,220	1104100
Number of owned dwellings	1920	1986	3906	5,030	3,005	8,035	12625	6270	18895	19,575	11,261	30,836	777480
Number of rented dwellings	715	309	1024	1,475	374	1,849	5650	834	6484	7,840	1,517	9,357	319090
Number of dwellings constructed before 1991	2265	1948	4213	5,805	2,942	8,747	15260	5896	21156	23,330	10,786	34,116	887450
Number of dwellings constructed between 1991 and 2001	370	343	713	665	451	1,116	3045	1212	4257	4,080	2,006	6,086	[illegible]
Average value of dwelling ($)	103943	117864	110424	77,567	115,465	90,558	111203	135568	118023	102,527	127,061	110,332	159698

Table A.9

School Attendance Characteristics of Battle River Basin Residents

	Lower Basin			Middle Basin			Upper Basin			Battle River Basin			ALBERTA
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Total population 15 years and over attending school full time													
Age group 15-19 attending full time (50)	71.0%	80.5%	75.9%	80.1%	78.2%	79.2%	65.0%	75.7%	68.5%	68.5%	77.2%	71.9%	53.9%
Age group 20-24 attending full time	15.1%	16.1%	15.6%	11.4%	17.9%	14.4%	19.9%	14.2%	18.0%	17.8%	15.5%	16.9%	25.7%
Total population 15 years and over attending school part time													
Age group 15-19 attending part time (50)	5.4%	4.1%	4.7%	4.5%	2.9%	3.8%	4.9%	2.0%	3.9%	4.9%	2.6%	4.0%	9.1%
Age group 20-24 attending part time	9.7%	6.5%	8.0%	9.1%	5.0%	7.2%	4.9%	4.4%	4.7%	6.2%	5.0%	5.7%	16.9%

Table A.10

Educational Characteristics of Battle River Basin Residents

	Lower Basin			Middle Basin			Upper Basin			Battle River Basin			
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	ALBERTA
Highest Level of Schooling													
Total population aged 20-34	**1190**	**1317**	**2507**	**2,555**	**1,410**	**3,965**	**8015**	**2661**	**10676**	**11,760**	**5,388**	**17,148**	**641520**
Less than a high school graduation certificate	18.9%	31.5%	25.5%	20.7%	24.8%	22.2%	26.0%	23.8%	25.5%	24.1%	26.0%	24.7%	18.2%
High school graduation certificate and/or some postsecondary (46)	26.0%	26.9%	26.5%	28.8%	28.4%	28.6%	32.3%	32.1%	32.2%	30.9%	29.9%	30.6%	32.2%
Trades certificate or diploma	15.1%	17.0%	16.1%	15.3%	14.8%	15.1%	12.8%	13.8%	13.0%	13.5%	14.8%	14.0%	11.6%
College certificate or diploma (47)	24.8%	16.7%	20.5%	18.8%	17.1%	18.2%	17.1%	19.6%	17.7%	18.2%	18.2%	18.2%	18.0%
University certificate, diploma or degree	17.6%	7.7%	12.4%	10.8%	8.3%	9.9%	11.5%	10.3%	11.2%	12.0%	9.1%	11.1%	20.0%
Total population aged 35-44	**1150**	**1220**	**2370**	**2,305**	**1,745**	**4,050**	**6925**	**3489**	**10414**	**10,380**	**6,454**	**16,834**	**515670**
Less than a high school graduation certificate	27.0%	24.8%	25.8%	23.8%	24.9%	24.3%	24.2%	26.9%	25.1%	24.4%	25.9%	25.0%	20.3%
High school graduation certificate and/or some postsecondary (46)	24.7%	27.7%	26.3%	28.3%	26.7%	27.6%	25.5%	28.2%	26.4%	26.0%	27.7%	26.7%	23.8%
Trades certificate or diploma	17.4%	20.7%	19.1%	17.0%	19.5%	18.0%	19.7%	20.5%	20.0%	18.8%	20.3%	19.4%	16.4%
College certificate or diploma (47)	20.5%	18.3%	19.4%	15.1%	12.6%	14.0%	18.0%	16.8%	17.6%	17.6%	15.9%	17.0%	19.7%
University certificate, diploma or degree	10.0%	8.7%	9.3%	5.6%	8.1%	6.7%	12.3%	7.6%	10.7%	10.5%	7.9%	9.5%	19.8%
Total population aged 45-64	**1300**	**1666**	**2966**	**3,365**	**2,558**	**5,923**	**9890**	**5655**	**15545**	**14,555**	**9,879**	**24,434**	**658835**
Less than a high school graduation certificate	38.5%	37.1%	37.7%	34.8%	33.5%	34.2%	29.9%	34.9%	31.8%	31.8%	34.9%	33.1%	26.2%
High school graduation certificate and/or some postsecondary (46)	16.5%	22.5%	19.9%	17.4%	19.6%	18.3%	19.3%	19.0%	19.2%	18.6%	19.8%	19.1%	20.1%
Trades certificate or diploma	18.5%	14.6%	16.3%	18.9%	20.5%	19.6%	17.4%	18.1%	17.7%	17.9%	18.1%	18.0%	15.8%
College certificate or diploma (47)	15.4%	16.2%	15.9%	12.2%	10.5%	11.5%	15.9%	16.2%	16.0%	15.0%	14.8%	14.9%	17.1%
University certificate, diploma or degree	11.9%	8.9%	10.2%	11.9%	11.4%	11.7%	17.3%	11.8%	15.3%	15.6%	11.2%	13.8%	20.9%

Table A.11

Farm Ownership in the Battle River Basin

	Lower Basin				Middle Basin				Upper Basin				Battle River Basin				Alberta			
	1996		2001		1996		2001		1996		2001		1996		2001		1996		2001	
Total Farms	1232	%	1125	%	2294	%	2022	%	3251	%	2931	%	6777	%	6079	%	59007	%	53652	%
Sole Proprietorship	764	62.0	641	56.9	1486	64.8	1197	59.2	1983	61.0	1660	56.6	4233	62.5	3498	57.5	35938	60.9	30409	56.7
Partnership with written agreement	42	3.4	265	23.6	91	4.0	489	24.2	155	4.8	854	29.1	287	4.2	1608	26.5	2664	4.5	14012	26.1
Partnership without written agreement	244	19.8	34	3.1	506	22.1	78	3.9	850	26.1	134	4.6	1601	23.6	247	4.1	14008	23.7	2135	4.0
Corporation - Family	153	12.4	168	14.9	180	7.8	233	11.5	220	6.8	249	8.5	553	8.2	650	10.7	5248	8.9	6124	11.4
Corporation - Non-family	22	1.8	12	1.1	28	1.2	22	1.1	41	1.3	29	1.0	91	1.3	63	1.0	961	1.6	733	1.4
Other	7	0.6	5	0.4	3	0.1	3	0.1	2	0.1	5	0.2	12	0.2	13	0.2	188	0.3	239	0.4

Table A.12

Land Ownership (Acres) in the Battle River Basin

	Lower Basin				Middle Basin				Upper Basin				Battle River Basin				Alberta			
	1996		2001		1996		2001		1996		2001		1996		2001		1996		2001	
# Acres - Total	1453153	%	1498599	%	2659813	%	2603873	%	1642250	%	1633642	%	5755215	%	5736114	%	51964360	%	52058898	%
Owned - Farms	1172	95.1	1072	95.3	2173	94.7	1936	95.7	3086	94.9	2821	96.2	6431	94.9	5829	95.9	55878	94.7	51164	95.4
Owned - Acres	950245	65.4	923145	61.6	1828578	68.7	1755982	67.4	1114056	67.8	1104671	67.6	3892879	67.6	3783798	66.0	31344893	60.3	30701572	59.0
Rented/Leased - Farms	608	49.3	594	52.8	1175	51.2	1080	53.4	1263	38.8	1210	41.3	3045	44.9	2883	47.4	25722	43.6	24388	45.5
Rented/Leased - Acres	502907	34.6	575454	38.4	831213	31.3	847891	32.6	51[illegible]64	31.7	528971	32.4	1854084	32.2	1952316	34.0	20619467	39.7	21357326	41.0
Rented/Leased from Government - Farms	146	11.8	145	12.9	256	11.2	236	11.7	189	5.8	172	5.9	591	8.7	553	9.1	7567	12.8	6968	13.0
Rented/Leased from Government - Acres	562632	38.7	196534	13.1	164731	6.2	173555	6.7	115489	7.0	73686	4.5	842852	14.6	443775	7.7	10131862	19.5	10126861	19.5
Rented/Leased from Others - Farms	543	44.1	475	42.2	1044	45.5	823	40.7	1032	31.7	1034	35.3	2619	38.7	2332	38.4	21308	36.1	18085	33.7
Rented/Leased from Others - Acres	333276	22.9	305945	20.4	666481	25.1	504935	19.4	391418	23.8	382482	23.4	1391175	24.2	1193363	20.8	10487605	20.2	8964975	17.2
Average Farm Size	1180		1332		1160		1288		505		557		849		944		881		970	

Table A.13

Agricultural Land Use (Farms) in the Battle River Basin

	Lower Basin				Middle Basin				Upper Basin				Battle River Basin				Alberta			
	1996		2001		1996		2001		1996		2001		1996		2001		1996		2001	
Total Farms	1232	%	1125	%	2294	%	2022	%	3251	%	2931	%	6777	%	6079	%	59007	%	53652	%
Land in Crops	1088	88.3	1002	89.0	2066	90.1	1823	90.1	2699	83.0	2453	83.7	5852	86.8	5277	86.8	50268	85.2	46028	85.8
Summerfallow	501	40.7	367	32.6	892	38.9	632	31.3	528	16.2	439	15.0	1921	23.7	1438	23.7	15819	26.8	13268	24.7
Tame/Seeded Pasture	601	48.8	546	48.5	1066	46.5	945	46.7	1634	50.3	1512	51.6	3302	49.4	3003	49.4	25672	43.5	24103	44.9
Natural Land for Pasture	851	69.1	743	66.1	1609	70.2	1389	68.7	2136	65.7	1799	61.4	4597	64.7	3932	64.7	36451	61.8	31438	58.6
All Other Land	946	76.8	783	69.6	1819	79.3	1448	71.6	2689	82.7	2251	76.8	5455	73.7	4482	73.7	45975	77.9	3822	7.1
Irrigation	12	1.0	5	0.4	30	1.3	18	0.9	39	1.2	28	0.9	81	0.8	50	0.8	4914	8.3	4096	7.6
Commercial Fertilizer	865	70.2	675	60.0	1658	72.3	1249	61.8	1790	55.0	1533	52.3	4313	56.9	3458	56.9	21642	36.7	27075	50.5

Table A.14

Agricultural Land Use (Acres) in the Battle River Basin

	Lower Basin				Middle Basin				Upper Basin				Battle River Basin				Alberta			
	1996		2001		1996		2001		1996		2001		1996		2001		1996		2001	
# Acres	1453153	%	1498599	%	2659813	%	2603873	%	1642250	%	1633642	%	5755215	0.0	5736114	%	51964360	%	52058898	%
Land in Crops	753150	51.8	773876	51.6	1428685	53.7	1418821	54.5	937510	57.1	951092	58.2	3119346	54.8	3143790	54.8	23590033	45.4	24038861	46.2
Summerfallow	91714	6.3	67819	4.5	183895	6.9	122596	4.7	41092	2.5	33073	2.0	316702	3.9	223488	3.9	3550265	6.8	3053214	5.9
Tame/Seeded Pasture -	150955	10.4	184784	12.3	229885	8.6	288220	11.1	231217	14.1	268373	16.4	612058	12.9	741377	12.9	4731087	9.1	5512654	10.6
Natural Land for Pasture	380017	26.2	400952	26.8	637660	24.0	656798	25.2	306525	18.7	271333	16.6	1324202	23.2	1329082	23.2	16437251	31.6	16503920	31.7
All Other Land	77315	5.3	71167	4.7	179687	6.8	117439	4.5	125896	7.7	109771	6.7	382899	5.2	298377	5.2	3745724	7.2	2950249	5.7
Irrigation	1661	0.1	664	0.0	3846	0.1	972	0.0	4018	0.2	1492	0.1	9526	0.1	3128	0.1	1276547	2.5	1233649	2.4
Commercial Fertilizer	656926	45.2	603336	40.3	1217609	45.8	1073696	41.2	724619	44.1	703216	43.0	2599153	41.5	2380248	41.5	17375043	33.4	16556173	31.8

Table A.15

Number of Farms with Livestock in the Battle River Basin

	Lower Basin				Middle Basin				Upper Basin				Battle River Basin				Alberta			
	1996		2001		1996		2001		1996		2001		1996		2001		1996		2001	
Total Farms	1232	%	1125	%	2294	%	2022	%	3251	%	2931	%	6777	%	6079	%	59007	0%	53652	%
Hens & Chickens	105	8.5	72	6.4	193	8.4	150	7.4	324	10.0	305	10.4	622	8.7	527	8.7	5610	9.5	5055	9.4
Turkeys	28	2.3	14	1.2	50	2.2	33	1.7	66	2.0	59	2.0	145	1.7	106	1.7	1180	2.0	945	1.8
Total Cattle & Calves	800	65.0	739	65.7	1550	67.6	1343	66.4	2163	66.5	1842	62.9	4514	64.6	3925	64.6	36560	62.0	31774	59.2
Bulls - 1 yr & older	628	51.0	573	50.9	1271	55.4	1102	54.5	1664	51.2	1425	48.6	3563	51.0	3101	51.0	28146	47.7	24299	45.3
Total cows	743	60.3	681	60.5	1433	62.5	1267	62.7	1995	61.4	1696	57.9	4171	60.0	3645	60.0	33576	56.9	29237	54.5
Milk cows	50	4.0	17	1.5	96	4.2	38	1.9	237	7.3	143	4.9	383	3.3	199	3.3	2822	4.8	1422	2.7
Beef cows s	716	58.1	673	59.8	1392	60.7	1256	62.1	1857	57.1	1606	54.8	3965	58.1	3535	58.1	32048	54.3	28510	53.1
Heifers - 1 yr & olde	532	43.2	497	44.1	983	42.9	876	43.3	1414	43.5	1168	39.8	2930	41.8	2540	41.8	23933	40.6	20126	37.5
Steers - 1 yr & older	287	23.3	204	18.1	558	24.3	343	17.0	731	22.5	412	14.1	1576	15.8	960	15.8	12855	21.8	7698	14.3
Calves - under 1 yr.	704	57.2	676	60.0	1395	60.8	1266	62.6	1945	59.8	1701	58.0	4044	59.9	3642	59.9	32383	54.9	29298	54.6
Total Pigs	97	7.8	48	4.3	153	6.7	91	4.5	269	8.3	171	5.8	519	5.1	310	5.1	4173	7.1	2677	5.0
Boars	43	3.5	22	1.9	82	3.6	48	2.4	148	4.6	93	3.2	273	2.7	163	2.7	2152	3.6	1398	2.6
Sows & Gilts - Brreeding	48	3.9	26	2.3	88	3.8	52	2.5	159	4.9	110	3.8	294	3.1	188	3.1	2453	4.2	1613	3.0
Nursing & Weaner pigs	88	7.1	61	5.4	148	6.4	107	5.3	249	7.7	230	7.9	485	6.6	398	6.6	3871	6.6	3411	6.4
Grower & Finishing Pigs	0	0.0	38	3.4	0	0.0	78	3.9	0	0.0	137	4.7	0	4.2	253	4.2	0	0.0	2083	3.9
Total Sheep & Lambs -	52	4.2	51	4.6	73	3.2	94	4.6	179	5.5	204	7.0	303	5.7	349	5.7	2814	4.8	2987	5.6
Horses & Ponies	393	31.9	228	20.2	664	29.0	661	32.7	972	29.9	941	32.1	2029	30.1	1829	30.1	17951	30.4	17807	33.2
Goats	30	2.4	30	2.6	63	2.7	255	12.6	110	3.4	92	3.1	202	6.2	377	6.2	1863	3.2	1675	3.1
Bison	6	0.4	26	2.3	6	0.3	15	0.7	27	0.8	64	2.2	39	1.7	105	1.7	334	0.6	950	1.8
Deer & Elk	8	0.6	13	1.1	8	0.4	16	0.8	16	0.5	42	1.4	32	1.2	70	1.2	245	0.4	660	1.2
Total Sheep & Lambs	52	4.2	51	4.6	73	3.2	94	4.6	179	5.5	204	7.0	303	5.7	349	5.7	2814	4.8	2987	5.6

Table A.16

Livestock Populations in the Battle River Basin

	Lower Basin				Middle Basin				Upper Basin				Battle River Basin				Alberta			
	1996		2001		1996		2001		1996		2001		1996		2001		1996		2001	
	Total	Avg	Total	Avg	Total	Avg	Total	Avg	Total	Avg	Total	Avg	Total	Avg	Total	Avg	Total	Avg	Total	Avg
Hens & Chickens	63638	606	69663	965	167682	868	212028	1.417	693638	2.138	1137117	3.730	924959	1.486	1418808	2.694	9485635	1.691	12175246	2.409
Turkeys	2314	82	1570	115	2121	42	3671	110	88172	1.335	112237	1.900	92606	640	117479	1.107	842798	714	864438	915
Total Cattle & Calves	136276	170	160049	216	264627	171	278226	207	297122	137	310356	168	698026	155	748631	191	5942257	163	6615201	208
Bulls - 1 yr & older	3404	5	3941	7	5945	5	6032	5	5779	3	5660	4	15128	4	15633	5	118600	4	111379	5
Total cows	54832	74	64802	95	100008	70	106373	84	116553	58	128989	76	271393	65	300164	82	2119719	63	2183332	75
Milk cows	2002	40	2172	125	1928	20	1400	37	10727	45	9346	65	14657	38	12918	65	102830	36	84044	59
Beef cows s	52829	74	62630	93	98069	70	102696	82	105826	57	119643	74	256724	65	284969	81	2016889	63	2099288	74
Heifers - 1 yr & olde	15557	29	23181	47	33554	34	39588	45	47914	34	44133	38	97024	33	106902	42	952563	40	1159329	58
Steers - 1 yr & older	14676	51	10443	51	38399	69	28257	82	30714	42	25603	62	83790	53	64304	67	892696	69	991554	129
Calves - under 1 yr.	47807	68	57682	85	86721	62	97971	77	96162	49	105971	62	230690	57	261624	72	1858679	57	2169607	74
Total Pigs	38137	395	61502	1.278	48431	316	68219	748	110658	411	117536	687	197226	380	247258	797	1729810	415	2027533	757
Boars	232	5	173	8	299	4	321	7	700	5	455	5	1232	5	949	6	11471	5	9324	7
Sows & Gilts - Brreeding	4046	85	6031	229	4729	54	6040	117	11098	70	12705	115	19873	68	24776	132	174195	71	200478	124
Nursing & Weaner pigs	33692	384	55298	908	43405	293	61859	577	98859	396	104378	453	175956	363	221535	556	1544144	399	1817731	533
Grower & Finishing pigs	0	0	31846	840	0	0	40730	522	0	0	64337	470	0	0	136914	541	0	0	1132449	544
Total Sheep & Lambs -	3176	61	5140	100	4233	58	10076	108	10822	60	19224	94	18231	60	34439	99	259817	92	307302	103
Horses & Ponies	2317	6	2728	12	4449	7	5391	8	9592	10	11343	12	16358	8	19462	11	149960	8	159962	9
Goats	176	6	419	14	775	12	172	1	1994	18	2329	25	2945	15	2920	8	32960	18	42270	25
Bison	266	48	2794	108	22	3	1152	77	1287	48	5946	94	1574	41	9892	95	22782	68	79731	84
Deer & Elk	337	43	668	52	133	16	388	24	1148	71	3660	88	1618	50	4716	67	10687	44	39635	60

Table A.17

Farms Growing Crops in the Battle River Basin

	Lower Basin				Middle Basin				Upper Basin				Battle River Basin				Alberta			
	1996		2001		1996		2001		1996		2001		1996		2001		1996		2001	
Total Farms	1232	%	1125	%	2294	%	2022	0%	3251	%	2931	%	6777	%	6079	%	59007	%	53652	%
Total Wheat	719	58.4	517	45.9	1415	61.7	1022	50.6	830	25.5	719	24.5	2965	37.1	2258	37.1	19930	33.8	15596	29.1
Spring Wheat	712	57.8	512	45.5	1394	60.8	1017	50.3	814	25.1	710	24.2	2921	36.8	2239	36.8	19138	32.4	14725	27.4
Durum Wheat	11	0.9	15	1.3	29	1.3	14	0.7	15	0.5	8	0.3	55	0.6	37	0.6	2280	3.9	2249	4.2
Winter Wheat	5	0.4	7	0.6	7	0.3	14	0.7	7	0.2	8	0.3	19	0.5	29	0.5	511	0.9	384	0.7
Oats	468	38.0	367	32.6	847	36.9	675	33.4	857	26.4	607	20.7	2172	27.1	1649	27.1	15015	25.4	12074	22.5
Barley	652	53.0	508	45.1	1428	62.3	694	34.3	1471	45.3	1059	36.1	3552	37.2	2260	37.2	24314	41.2	17548	32.7
Mixed Grains	106	8.6	108	9.6	141	6.2	161	8.0	128	3.9	172	5.9	375	7.3	441	7.3	1857	3.1	2508	4.7
Corn for Grain	0	0.0	1	0.1	0	0.0	1	0.1	0	0.0	5	0.2	1	0.1	7	0.1	24	0.0	70	0.1
Buckwheat	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	7	0.0	6	0.0
Total Rye	48	3.9	34	3.0	94	4.1	90	4.4	44	1.4	52	1.8	187	2.9	176	2.9	1063	1.8	1139	2.1
Fall Rye	37	3.0	27	2.4	76	3.3	75	3.7	37	1.1	43	1.5	150	2.4	145	2.4	902	1.5	940	1.8
Spring Rye	12	1.0	7	0.7	20	0.9	18	0.9	9	0.3	7	0.3	41	0.5	33	0.5	182	0.3	223	0.4
Corn for Silage	0	0.0	4	0.3	1	0.0	8	0.4	4	0.1	22	0.8	5	0.6	34	0.6	103	0.2	291	0.5
Alfalfa - Farms	304	24.7	402	35.7	531	23.1	735	36.3	1283	39.5	1260	43.0	2118	39.4	2397	39.4	22114	37.5	23459	43.7
Other Tame Hay/Fodder	220	17.8	238	21.2	450	19.6	424	21.0	924	28.4	867	29.6	1594	25.2	1530	25.2	14937	25.3	14399	26.8
Canola	537	43.6	442	39.2	1012	44.1	740	36.6	713	21.9	607	20.7	2263	29.4	1789	29.4	13573	23.0	9162	17.1
Flaxseed	15	1.2	13	1.1	14	0.6	15	0.7	5	0.1	10	0.3	33	0.6	38	0.6	285	0.5	279	0.5
Soybeans	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	6	0.0	5	0.0
Mustard Seed	2	0.2	0	0.0	2	0.1	2	0.1	1	0.0	1	0.0	5	0.0	3	0.0	366	0.6	235	0.4
Dry Field Peas	81	6.6	148	13.1	157	6.9	246	12.2	123	3.8	131	4.5	362	8.6	525	8.6	2112	3.6	2874	5.4
Sunflower	1	0.1	0	0.0	0	0.0	1	0.1	0	0.0	0	0.0	2	0.0	2	0.0	28	0.0	36	0.1
Safflower	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	23	0.0	7	0.0
Potatoes	6	0.5	3	0.3	13	0.6	9	0.5	14	0.4	19	0.7	34	0.5	31	0.5	456	0.8	434	0.8
Lentils	1	0.1	0	0.0	0	0.0	2	0.1	0	0.0	2	0.1	1	0.1	4	0.1	108	0.2	103	0.2
Tree Fruits	0	0.0	0	0.0	1	0.1	0	0.0	3	0.1	0	0.0	5	0.0	0	0.0	61	0.1	0	0.0
Berries/Grapes	7	0.6	0	0.0	17	0.8	0	0.0	24	0.7	0	0.0	48	0.0	0	0.0	473	0.8	0	0.0
Vegetables for sale	9	0.7	6	0.5	11	0.5	11	0.5	22	0.7	25	0.9	42	0.7	42	0.7	594	1.0	509	0.9
Nursery	4	0.3	3	0.3	11	0.5	7	0.4	34	1.0	30	1.0	49	0.7	40	0.7	584	1.0	586	1.1
Sod	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0	0	0.0	1	0.0	36	0.1	29	0.1

Table A.18

Crop Production (Acres) in the Battle River Basin

	Lower Basin				Middle Basin				Upper Basin				Battle River Basin				Alberta			
	1996		2001		1996		2001		1996		2001		1996		2001		1996^		2001	
Total Acres	1453153	%	1498599	%	2659813	%	2603873	%	1642250	%	1633642	%	5755215	%0	5736114	%	51964360	%	52058898	%
Total Wheat	277529	36.8	219629	28.4	554262	38.8	472181	33.3	185284	19.8	202610	21.3	1017074	28.5	894420	28.5	7324846	31.1	6852596	28.5
Spring Wheat	275364	36.6	215780	27.9	554906	38.8	463671	32.7	170234	18.2	200464	21.1	1000504	28.0	879916	28.0	6448110	27.3	5809275	24.2
Durum Wheat	1562	0.2	183	0.0			4732	0.3	1002	0.1	326	0.0		0.2	5240	0.2	781627	3.3	962906	4.0
Winter Wheat	603	0.1	40	0.0			1721	0.1			595	0.1		0.1	2356	0.1	95109	0.4	80415	0.3
Oats	66989	8.9	65687	8.5	105536	7.4	111648	7.9	54454	5.8	41213	4.3	226979	7.0	218548	7.0	1388179	5.9	1364674	5.7
Barley	96582	12.8	159298	20.6	314805	22.0	228624	16.1	291355	31.1	223905	23.5	702742	19.5	611827	19.5	5775824	24.5	4902090	20.4
Mixed Grains	15235	2.0	24333	3.1	23533	1.6	35980	2.5	10063	1.1	21924	2.3	48832	2.6	82237	2.6	226374	1.0	404174	1.7
Corn for Grain	0	0.0	21	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	21	0.0	2559	0.0	5018	0.0
Buckwheat	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	407	0.0	178	0.0
Total Rye	4077	0.5	7318	0.9	11186	0.8	10272	0.7	2214	0.2	3285	0.3	17476	0.7	20876	0.7	102865	0.4	117138	0.5
Fall Rye			2526	0.3	6286	0.4	8427	0.6	1345	0.1	2105	0.2		0.4	13057	0.4	80701	0.3	89480	0.4
Spring Rye	827	0.1	4793	0.6	1914	0.1	1471	0.1	529	0.1	900	0.1	3270	0.2	7164	0.2	22164	0.1	27658	0.1
Corn for Silage	0	0.0	63	0.0	0	0.0	213	0.0	47	0.0	1341	0.1	47	0.1	1617	0.1	12800	0.1	36814	0.2
Alfalfa - Farms	39169	5.2	67509	8.7	97914	6.9	124566	8.8	140305	15.0	157359	16.5	277388	11.1	349434	11.1	2997653	12.7	3915607	16.3
Other Tame Hay/Fodder	24509	3.3	38584	5.0	52910	3.7	70197	4.9	94215	10.0	106350	11.2	171634	6.8	215132	6.8	1755512	7.4	2279767	9.5
Canola	126059	16.7	148555	19.2	254436	17.8	242329	17.1	138871	14.8	161531	17.0	519367	17.6	552414	17.6	3151296	13.4	2660509	11.1
Flaxseed	2267	0.3	2874	0.4	1834	0.1	2035	0.1	686	0.1	0	0.0	4787	0.2	4909	0.2	34082	0.1	40219	0.2
Soybeans	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1059	0.0	88	0.0
Mustard Seed	0	0.0	0	0.0	179	0.0	139	0.0	0	0.0	0	0.0	179	0.0	139	0.0	91909	0.4	57116	0.2
Dry Field Peas	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1705	0.0	1616	0.0
Sunflower	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1628	0.0	915	0.0
Safflower	126	0.0	4	0.0	171	0.0	196	0.0	259	0.0	1292	0.1	555	0.0	1492	0.0	31488	0.1	58341	0.2
Potatoes	12638	1.7	35280	4.6	22992	1.6	62671	4.4	17369	1.9	23028	2.4	52999	3.8	120979	3.8	286037	1.2	608217	2.5
Lentils	55	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	55	0.0	0	0.0	19257	0.0	19649	0.0
Tree Fruits	0	0.0	0	0.0	0	0.0			1	0.0	0	0.0	1				5164	0.0	0	0.0
Berries/Grapes	8	0.0	0	0.0	65	0.0	0	0.0	75	0.0	0	0.0	148	0.0	0	0.0	1634	0.0	0	0.0
Vegetables for sale	18	0.0	29	0.0	34	0.0	4	0.0	40	0.0	366	0.0	92	0.0	399	0.0	13743	0.1	14194	0.1
Nursery	14	0.0	14	0.0			15	0.0	381	0.0	354	0.0		0.0	383	0.0	6160	0.0	6642	0.0
Sod	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	6272	0.0	7094	0.0

Appendix B

Summary of Licences and Registrations in the Battle River Basin, by Sub-Basin, 2004

		Upper Basin				Middle Basin				Lower Basin				Total Basin			
		#	Allocation	Use	Return	#	Allocation	Use	Return	#	Allocation	Use	Return	#	Allocation	Use	Return
Surface Water																	
Municipal		9	6594	2102	4492	5	875	279	596	2	6746	1332	5414	16	14215	3713	10502
Agriculture	Stockwatering	85	271	271	0	278	1858	1858	0	47	206	206	0	410	2335	2335	0
	Feedlots	0	0	0	0	3	142	142	0	0	0	0	0	3	142	142	0
	Irrigation	35	2481	1942	539	118	7385	6734	651	23	2331	1810	522	176	12197	10486	1712
	Gardening	5	19	19	0	0	0	0	0	0	0	0	0	5	19	19	0
Industry	Cooling	0	0	0	0	3	691737	13741	677996	0	0	0	0	3	691737	13741	677996
	Injection	3	2378	2378	0	5	5142	5002	141	1	9	9	0	9	7529	7389	141
	Other	9	526	476	50	5	318	318	0	0	0	0	0	14	844	794	50
Wildlife	Fish Ponds	5	95	95	0	5	95	95	0	1	19	19	0	11	209	209	0
	Wetlands	49	9232	9232	0	43	5517	4829	688	23	2880	2830	51	115	17629	16891	739
Recreation		13	1099	936	162	6	336	250	86	1	10	9	1	20	1445	1195	249
Water	Flood	1	51	51	0	7	30	30	0	3	1476	1020	456	11	1557	1101	456
	Other	1	2	2	0	0	0	0	0	0	0	0	0	1	2	2	0
	TOTAL	215	22748	17504	5243	478	713435	33278	680158	101	13677	7235	6444	794	749860	58017	691845
Registrations		1864	716	716	0	3230	864	864	0	1551	375	375	0	6645	1955	1955	0
TOTAL		2079	23464	18220	5243	3708	714299	34142	680158	1652	14052	7610	6444	7439	751815	59972	691845
Groundwater																	
Municipal		83	5694	2859	2835	99	1943	1264	679	33	516	334	182	215	8153	4457	3696
Agriculture	Stockwatering	670	2421	2421	0	296	1537	1537	0	140	894	894	0	1106	4852	4852	0
	Feedlots	28	170	170	0	10	250	250	0	20	198	198	0	58	618	618	0
	Irrigation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gardening	3	11	11	0	6	16	16	0	0	0	0	0	9	27	27	0
Industry	Cooling	1	5	5	0	0	0	0	0	0	0	0	0	1	5	5	0
	Injection	6	327	327	0	6	305	305	0	29	979	979	0	41	1611	1611	0
	Other	21	392	392	0	26	236	230	6	2	66	66	0	49	694	688	6
Wildlife	Fish Ponds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreation		13	231	231	0	14	105	105	0	8	87	87	0	35	423	423	0
Water	Drainage	4	345	13	332	1	137	7	130	0	0	0	0	5	482	20	462
	Other	3	29	29	0	1	1	1	0	0	0	0	0	4	30	30	0
	TOTAL	832	9625	6458	3167	459	4530	3715	815	232	2740	2558	182	1523	16895	12731	4164
Registrations		2465	2765	2765	0	1597	1394	1394	0	798	791	791	0	4860	4950	4950	0
TOTAL		3297	12390	9223	3167	2056	5924	5109	815	1030	3531	3349	182	6383	21845	17681	4164
Total Water																	
Municipal		92	12288	4961	7327	104	2818	1543	1275	35	7262	1666	5596	231	22368	8170	14198
Agriculture	Stockwatering	755	2692	2692	0	574	3395	3395	0	187	1100	1100	0	1516	7187	7187	0
	Feedlots	28	170	170	0	13	392	392	0	20	198	198	0	61	760	760	0
	Irrigation	35	2481	1942	539	118	7385	6734	651	23	2331	1810	522	176	12197	10486	1712
	Gardening	8	30	30	0	6	16	16	0	0	0	0	0	14	46	46	0
Industry	Cooling	1	5	5	0	3	691737	13741	677996	0	0	0	0	4	691742	13746	677996
	Injection	9	2705	2705	0	11	5447	5307	141	30	988	988	0	50	9140	9000	141
	Other	30	918	868	50	31	554	548	6	2	66	66	0	63	1538	1482	56
Wildlife	Fish Ponds	5	95	95	0	5	95	95	0	1	19	19	0	11	209	209	0
	Wetlands	49	9232	9232	0	43	5517	4829	688	23	2880	2830	51	115	17629	16891	739
Recreation		26	1330	1167	162	20	441	355	86	9	97	96	1	55	1868	1618	249
Water	Flood	5	396	64	332	8	167	37	130	3	1476	1020	456	16	2039	1121	918
	Other	4	31	31	0	1	1	1	0	0	0	0	0	5	32	32	0
	TOTAL	1047	32373	23962	8410	937	717965	36993	680973	333	16417	9793	6626	2317	766755	70748	696009
Registrations		4329	3481	3481	0	4827	2258	2258	0	2349	1166	1166	0	11505	6905	3905	0
TOTAL		5376	35854	27443	8410	5764	720223	39251	680973	2682	17583	10959	6626	13822	773660	77653	696009

Appendix C

Municipal Water and Wastewater Information

Table C.1

Annual Municipal Water Licences, Water Use, and Wastewater Discharges

	Water Source	Population 2001	Water Use: Licence (dam^3)	Type Reported	Reported Use (dam^3)	Litres per Person/day	Per cent of Licence	Discharge Dam3	Consumption: Dam3	Per cent of Withdrawal
Upper Basin										
Bittern Lake	Camrose	221	47	Raw	16	199	34%	no data		
Camrose	Surface	14854	3084	Raw	2176	401	71%			
				Treated	1997	368	65%	2500	-324	115%
Hay Lakes	Surface	346	88	Raw	165.8	479	69%	63	-3	105%
Wetaskiwin	Surface	11154	2467	Raw	1847	454	75%			
				Treated	1488	366	60%	356	1491	19%
Millet	Ground	2037	153	Raw	234	314	153%			
				Treated	231	310	151%	228	6	97%
Bawlf	Ground	362	56	Raw	44	333	79%	no data		
Ferintosh (2003)	Ground	150	15		12	211	77%	no data		
Lacombe	Ground	9384	2805	Treated	1177	363	42%	1130	47	96%
Edberg	Ground	150	16	Raw	11	201	70%	7	4	67%
New Norway	Ground	292	48		35	328		no data		
Ponoka	Ground	6330	1647	Treated	839	363	51%	1600	-761	191%
Rosalind	Ground	190	41	Treated	29	418	70%	no data		
Middle Basin										
Castor	Surface	935	247	Raw	163	479	66%	99	64	61%
Stettler	Red Deer	5215	1700	Treated	889	467	52%			
				Raw	987	518	58%	791	196	80%
Botha	Stettler	186	0	Raw	21	312		8	13	40%
Gadsby	Stettler	40	0	Raw	18			no data		
Viking	CU Water	1052	548	no data						

Table C.1 (continued)

Annual Municipal Water Licences, Water Use, and Wastewater Discharges

	Water Source	Population 2001	Water Use: Licence (dam^3)	Type Reported	Reported Use (dam^3)	Litres per Person/day	Per cent of Licence	Discharge Dam3	Consumption: Dam3	Per cent of Withdrawal
Upper Basin										
Alliance	Ground	171	42	Raw	39	625	92%	22	17	57%
				Treated	38	609	91%			
Amisk	Ground	181	23	Raw	22	333	95%	0	22	0%
Coronation	Ground	902	342	Raw	197	598	58%	87	110	44%
Czar	Ground	205	0	no data						
Daysland	Ground	779	167		101	355	60%	no data		
Donalda	Ground	230	84	no data						
Forestburg (2003)	Ground	870	178		110	346	62%	no data		
Galahad	Ground	161	43		22	374	50%	20	2	89%
Halkirk	Ground	117	21	Treated	14	328	66%	0	14	0%
Hardisty	Ground	743	136	Raw	174	642	128%	no data		
				Treated	148	546	109%			
Heisler	Ground	183	37		21	314	56%	16	5	75%
Hughenden	Ground	235	63		33	385	53%	0	33	0%
Killam	Ground	1004	214	Treated	183	499	86%	no data		
Lougheed (2003)	Ground	228	62		70	841	112%	56	14	80%
Sedgewick	Ground	865	227		124	393	55%	0	24	0%
Strome	Ground	273	74	Raw	34	341	46%	14	20	40%
Veteran	Ground	292	47		50	469	106%	no data		
Lower Basin										
Wainwright	Surface	5117	6746	Raw	894	479	13%	955	-61	107%
Chauvin	Ground	366	83	Raw	75	561	90%	5	70	7%
Edgerton	Ground	403	77	Raw	38	258	49%	no data		
Paradise Valley	Ground	152	37	Treated	27	487	73%	0	27	0%
Irma	Ground	435	148		49	309	33%	no data		

Table C.2

Monthly Municipal Water Use and Wastewater Discharges

2004	Source	Licence	Unit		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Dam3
Upper Basin																	
Bittern Lake	Camrose	Water	Raw	day avg	37	38	39	39	51	63	49	42	42	42	49	38	16
		Discharge			no data												
Camrose	Surface	Water	m3	day avg	5511	6147	5400	5658	6533	7159	5992	6050	5697	5718	5567	6100	2176
				day avg	5141	5051	5025	5271	6080	6758	5640	5711	5334	5322	5161	5159	1997
		Discharge	m3	Total	0	0	0	1200000	0	0	0	0	0	1300000	0	0	2500
	Surface	Water	m3	day avg	175	146	153	160	193	177	158	164	166	168	165	165	165 8
Hay Lakes		Discharge		Total	0	0	0	0	0	0	0	0	63371		0	0	63
			m3	day avg	4616	4776	4614	4658	6100	6367	5374	5477	4809	4502	4709	4707	1847
	Surface	Water	m3	day avg	3669	3976	3807	3933	4717	4948	4387	4311	3976	3772	3741	3693	1488
Wetaskiwin		Discharge	m3	Total	29367	22403	25005	21738	39892	42546	30587	36138	24974	22614	29042	31433	356
	Ground	Water	m3	day avg	618	658	632	574	661	759	738	702	595	577	570	592	234
Millet			m3	day avg	609	660	593	578	648	761	722	706	575	572	573	588	231
		Discharge	m3	Total	0	0	0	0	0	0	227621	0	0	0	0	0	228
Bawlf	Ground	Water	m3	day avg	101	98	99	100	133	156	101	111	129	148	153	117	44
		Discharge															no data
Ferintosh (2003)	Ground	Water	m3	day avg	30	33	37	36	35	29	39	31	30	26	25	29	12
		Discharge	no data														
	Ground	Water	m3	day avg	3031	3101	3004	3214	3540	3629	3404	3225	3322	3188	3109	2915	1177
Lacombe		Discharge	m3	Total	0	0	0	540000	0	0	0	0	0	590000	0	0	1130
	Ground	Water	m3	day avg	29	29	33	31	31	43	32	31	28	27	30	27	11
Edberg		Discharge	m3	Total	0	0	0	0	0	0	0	0	0	0	7388	0	7
New Norway	Ground	Water	m3	day avg.	91	84	97	96	108	136	108	98	90	87	79	76	35
		Discharge			no data												
	Ground	Water	m3	day avg	2163	2248	2232	2199	2549	2584	2617	2460	2144	2190	2042	2170	839
Ponoka		Discharge	m3	Total				600000	200000					800000			1600
	Ground	Water	m3	day avg	66	66	71	74	102	114	85	92	63	77	66	71	29
Rosalind		Discharge			no data												

Table C.2 (continued)

Monthly Municipal Water Use and Wastewater Discharges

2004	Source	Licence	Unit		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Dam3
Middle Basin																	
Castor	Surface	Water	m3	day avg	359	448	481	435	496	510	501	453	446	462	388	391	163
		Discharge	m3	Total	0	0	0	0	0	0	0	0	0	98682	0		99
Stettle r	Red Deer	Water	m3	day avg	2204	2177	2173	2418	2685	2908	2570	2656	2524	2377	2327	2221	889
		Water	m3	day avg	2433	2404	2435	2740	2962	3205	2864	2943	2808	2602	2565	2486	987
		Discharge	m3	Total	0	0	0	0	56339	74496	130274	390929	70034	69070	0	0	791
Botha	Stettler	Water	m3	day avg	57	46	48	55	81	89	72	61	49	49	42	46	21
		Discharge	m3	Total	0	0	0	0	0	0	0	0	8478	0	0	0	8
Gadsby	Stettler	Water		day avg	43	48	52	50	54	59	48	52	53	50	45	47	18
		Discharge			no data												
Viking	CU Water	Water			no data												
		Discharge			no data												
Alliance	Ground	Water	m3	day avg	103	96	121	126	123	125	113	100	92	93.5	93	88	39
			m3	day avg	92	86	117	137	114	138.5	115	96	88	93	90	90	38
		Discharge	m3	Total	0	0	0	10500	0	0	0	0	0	11000	0	0	22
Amisk	Ground	Water	m3	day avg	56	53	51	60	68	71	61	64	56	58	59	63	22
		Discharge	m3	Total	0	0	0	0	0	0	0	0	0	0	0	0	0
Coronation	Ground	Water	m	day avg	523	629	581	547	569	604	546	538	468	473	509	482	197
		Discharge	m3	Total	0	0	0	0	0	0	0	0	0	0	87000	0	87
Czar	Ground	Water			0	0	0	0	0	0	0	0	0	0	0	0	0
		Discharge			no data												
Daysland	Ground	Water	m3														101
		Discharge			no data												
Donalda	Ground	Water			no data												
		Discharge			no data												
Forestburg (2003)	Ground	Water	m3	day avg.	261	256	238	248	358	428	388	303	298	316	263	274	110
		Discharge			no data												
Galahad	Ground	Water		day avg	49	50	52	64	77	87	70	65	53	50	49	44	22
		Discharge	m3	Total	0	0	0	0	0	0	0	0	0	0	19584	0	20
Halkirk	Ground	Water		day avg	51	68	85	37	29	30	25	31	25	25	24	24	14
		Discharge			0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.2 (continued)

Monthly Municipal Water Use and Wastewater Discharges

2004	Source	Licence	Unit		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Dam3
Hardisty	Ground	Water	m3	day avg	381	403	447	393	459	662	472	493	517	575	466	464	174
		Water	m3	day avg	363	377	420	368	440	555	376	428	391	472	343	348	148
Heisler		Discharge			no data												
	Ground	Water	m3	day avg	67	50	50	52	61	77	56	65	44	49	53	56	21
Hughenden		Discharge	m3	Total	0	0	0	0	0	0	0	0	0	0	15711	0	16
	Ground	Water	m3	day avg	69	74	66	71	166	124	114	96	63	91	75	83	33
Killam		Discharge		Total	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ground	Water	m3	day avg	416	443	444	480	649	651	525	556	493	480	447	436	183
		Discharge			no data												
Lougheed (2003)	Ground	Water	m3	day avg	194	104	149 2	176	222	292	356	168	169	160	133	165	70
		Discharge	m3	Total	0	0	0	200	0		0	0	0	0	55756	0	56
Sedgewick	Ground	Water	m3	day avg	336	321	245	277	460	479	391	407	293	292	279	292	124
		Discharge	m3	Total	0	0	0	0	0	0	0	0	0	0	0	0	0
Strome	Ground	Water	m3	day avg	78	87	92	107	117	105	89	103	82	87	83	86	34
		Discharge	m3	Total	0	0	0	0	0	0	0	0	0	13636	0	0	14
Veteran	Ground	Water	m3														50
		Discharge			no data												
Lower Basin																	
Chauvin	Ground	Water	m3	day avg	140	149	155	186	227	239	250	255	173	221	234	234	75
		Discharge		Total	0	0	0	0	0	5496	0	0	0	0	0	0	5
Edgerton	Ground	Water	m3	day avg	100	100	104	108	121	130	100	111	92	91	84	100	38
		Discharge			no data												
Paradise Valley	Ground	Water	m3	day avg	41	49	51	40	45	49	37	38	41	58	45	48	27
		Discharge	m3	Total	0	0	0	0	0	0	0	0	0	0	0	0	0
Irma	Ground	Water	m3														49
		Discharge			no data												
Wainwright	Surface	Water	m3	day avg	2147	2266	2233	2285	2532	2645	3064	2995	2573	2445	2153	2045	894
		Discharge		day avg	2271	2330	2412	2473	2662	2858	2905	3114	3061	2705	2411	2208	955

Appendix D

Population Forecasts and Municipal Water Use Forecasts

Table D.1

Population Forecast: Base Case Scenario

Base Case		2001	2005	2010	2015	2020	2025	2030	Total Change	5-year Change	Annual Change
	Urban	46056	47898	50293	52808	55448	58221	61132	32.7%	5.0%	0.98%
Upper	Rural	25326	26339	27656	29039	30491	32015	33616	32.7%	5.0%	0.98%
	Total	71382	74237	77949	81846	85939	90236	94748	32.7%	5.0%	0.98%
	Urban	15732	15443	15087	14740	14401	14070	13746	-12.6%	-2.3%	-0.46%
Middle	Rural	10163	10042	9891	9743	9596	9452	9311	-8.4%	-1.5%	-0.30%
	Total	25895	25484	24978	24483	23998	23523	23057	-11.0%	-2.0%	-0.40%
	Urban	6473	6525	7590	7666	7743	7820	7898	22.0%	1.0%	0.69%
Lower	Rural	7229	7344	7491	7641	7794	7950	8109	12.2%	2.0%	0.40%
	Total	13702	13869	15081	15307	15537	15770	16007	16.8%	8.7%	0.54%
	Urban	68261	69866	72971	75214	77592	80111	82776	21.3%	4.4%	0.67%
Basin	Rural	42718	43725	45038	46422	47881	49417	51035	19.5%	3.0%	0.62%
	Total	110979	113590	118009	121636	125473	129528	133812	20.6%	3.9%	0.65%

Table D.2

Population Forecast: High Growth Scenario

High Growth		2001	2005	2010	2015	2020	2025	2030	Total Change	5-year Change	Annual Change
	Urban	46056	48635	520310	55682	59580	63751	68213	48.1%	7.0%	1.36%
Upper	Rural	25326	26744	28616	30619	32763	35056	37510	48.1%	7.0%	1.36%
	Total	71382	75379	80656	86302	92343	98807	105723	48.1%	7.0%	1.36%
	Urban	15732	15732	15732	15732	15732	15732	15732	0.0%	0.0%	0.00%
Middle	Rural	10163	10163	10163	10163	10163	10163	10163	0.0%	0.0%	0.00%
	Total	25895	25895	25895	25895	25895	25895	25895	0.0%	0.0%	0.00%
	Urban	6473	6577	7708	7862	8020	8180	8343	28.9%	2.0%	0.88%
Lower	Rural	7229	7402	7624	7853	8089	8331	8581	18.7%	3.0%	0.59%
	Total	13702	13979	15332	15715	16108	16511	16925	23.5%	9.7%	0.73%
	Urban	68261	70944	75480	79277	83332	87663	92289	35.2%	6.4%	1.05%
Basin	Rural	42718	44310	46404	48636	51015	53551	56255	31.7%	4.7%	0.95%
	Total	110979	115253	121884	127913	134346	141214	148544	33.8%	5.8%	1.01%

Table D.3

Population Forecast: Low Growth Scenario

Low Growth		2001	0.0%	2005	2010	2015	202	2025	2030	Total Change	5-year Change	Annual Change
	Urban	46056		47530	49431	51408	53465	55603	57827	25.6%	4.0%	0.79%
Upper	Rural	25326		26136	27182	28269	29400	30576	31799	25.6%	4.0%	0.79%
	Total	71382		73666	76613	79677	82864	86179	89626	25.6%	4.0%	0.79%
	Urban	15732		15229	14619	14035	13473	12934	12417	-21.1%	-4.0%	-0.81%
Middle	Rural	10163		9920	9622	9333	9053	8782	8518	-16.2%	-3.0%	-0.61%
	Total	25895		25148	24241	23368	22527	21716	20935	-19.2%	-3.6%	-0.73%
	Urban	6473		6473	7473	7473	7473	7473	7473	15.4%	0.0%	0.50%
Lower	Rural	7229		7287	7359	7433	7507	7582	7658	5.9%	1.0%	0.20%
	Total	13702		13760	14832	14906	14980	15055	15131	10.4%	7.8%	0.34%
	Urban	68261		69231	71523	72916	74411	76010	77717	13.9%	3.3%	0.45%
Basin	Rural	42718		43342	44163	45035	45960	46940	47975	12.3%	1.9%	0.40%
	Total	110979		112574	115687	117951	120371	122950	125693	13.3%	2.8%	0.43%

Table D.4

Municipal Water Use Forecast: Base Case Scenario

Base Case			Population 2001	Litres per person per day	2001	2005	2010	2015	2020	2025	2030	Total Change	5-year Change	Annual Change
Upper	Urban	Surface	26575	98	951	989	1,038	1,090	1,144	1,202	1,262	32.7%	5.0%	0.98%
		Ground	18895	98	676	53	56	58	61	64	68	-90.0%	5.0%	-7.63%
		Imported	0	98	0	650	683	717	752	790	830		5.0%	
		Other	586	98	265	276	289	304	319	335	352	32.7%	5.0%	0.98%
		Total	46056		1891	1967	2066	2169	2277	2391	2511	32.7%		0.98%
	Rural		25326	98	662	688	722	759	796	836	878	32.7%	5.0%	0.98%
	Sub-Total		71382		2553	2655	2788	2927	3074	3227	3389	32.7%		0.98%
Middle	Urban	Surface	935	98	33	33	32	31	31	30	29	-12.6%	-2.3%	-0.46%
		Ground	7439	98	266	244	238	233	228	222	217	-18.4%	-2.3%	-0.70%
		Imported	6493	98	232	249	243	238	232	227	222	-4.6%	-2.3%	-0.16%
		Other	865	98	50	49	48	47	46	45	44	-12.6%	-2.3%	-0.46%
		Total	15732		582	575	562	549	536	524	512	-12.0%		-0.44%
	Rural		10163	98	344	340	335	330	325	320	315	-8.4%	-1.5%	-0.30%
	Sub-Total		25895		926	915	897	879	861	844	827	-10.7%		-0.39%
Lower	Urban	Surface	5117	98	183	184	186	188	190	192	194	5.9%	1.0%	0.20%
		Ground	1356	98	49	49	49	50	50	51	51	5.9%	1.0%	0.20%
		Other			40	40	40	40	40	40	40	0.0%	0.0%	0.00%
		Total	6473		272	273	276	278	280	283	285	5.1%		0.17%
	Rural		7229	98	219	223	227	232	237	241	246	12.2%	2.0%	0.40%
	Sub-Total		13702		491	496	503	510	517	524	531	8.2%		0.27%
TOTAL			**110979**		**3970**	**4067**	**4188**	**4316**	**4452**	**4596**	**4747**	**19.6%**		**0.62%**

Table D.5

Municipal Water Use Forecast: High Growth Scenario

Base Case			Population 2001	Litres per person per day	2001	2005	2010	2015	2020	2025	2030	Total Change	5-year Change	Annual Change
Upper	Urban	Surface	26575	98	951	1,004	1,074	1,149	1,230	1,316	1,408	48.1%	7.0%	1.7%
		Ground	18895	98	676	53	57	61	65	69	74	-89.0%	7.0%	-8.8%
		Imported	0	98	0	650	696	744	796	852	912		7.0%	
		Other	586	98	265	280	299	320	343	367	392	48.1%	7.0%	1.7%
		Total	46056		1891	1987	2126	2275	2434	2604	2786	47.3%		1.6%
	Rural		25326	98	662	699	747	800	856	916	980	48.1%	7.0%	1.7%
	Sub-Total		71382		2553	2685	2873	3074	3290	3520	3766	47.5%		1.6%
Middle	Urban	Surface	935	98	33	33	33	33	33	33	33	0.0%	0.0%	0.0%
		Ground	7439	98	266	244	244	244	244	244	244	-8.3%	0.0%	-0.4%
		Imported	6493	98	232	249	249	249	249	249	249	7.2%	0.0%	0.3%
		Other	865	98	50	50	50	50	50	50	50	0.0%	0.0%	0.0%
		Total	15732		582	576	576	576	576	576	576	-0.9%		0.0%
	Rural		10163	98	344	344	344	344	344	344	344	0.0%	0.0%	0.0%
	Sub-Total		25895		926	921	921	921	921	921	921	-0.6%		0.0%
Lower	Urban	Surface	5117	98	183	186	190	193	197	201	205	12.2%	2.0%	0.5%
		Ground	1356	98	49	49	50	51	52	53	54	12.2%	2.0%	0.5%
		Other			40	40	40	40	40	40	40	0.0%		0.0%
		Total	6473		272	275	280	285	290	295	300	10.4%		0.4%
	Rural		7229	98	219	225	231	238	246	253	261	18.7%	3.0%	0.7%
	Sub-Total		13702		491	500	511	523	535	548	560	14.1%		0.6%
TOTAL			**110979**		**3970**	**4106**	**4305**	**4518**	**4745**	**4988**	**5247**	**32.2%**		**1.2%**

Table D.6

Municipal Water Use Forecast: Low Growth Scenario

Base Case			Population 2001	Litres per person per day	2001	2005	2010	2015	2020	2025	2030	Total Change	5-year Change	Annual Change
Upper	Urban	Surface	26575	98	951	981	1,020	1,061	1,103	1,148	1,194	25.6%	4.0%	0.79%
		Ground	18895	98	676	53	55	57	60	62	64	-90.5%	4.0%	-7.78%
		Imported	0	98	0	650	676	703	731	760	791		4.0%	
		Other	586	98	265	273	284	296	308	320	333	25.6%	4.0%	0.79%
		Total	46056		1891	1957	2036	2117	2202	2290	2382	25.9%		0.80%
	Rural		25326	98	662	683	710	738	768	799	831	25.6%	4.0%	0.79%
	Sub-Total		71382		2553	2640	2746	2856	2970	3089	3212	25.8%		0.80%
Middle	Urban	Surface	935	98	33	32	31	30	29	27	26	-21.1%	-4.0%	-0.81%
		Ground	7439	98	266	244	234	225	216	207	199	-25.2%	-4.0%	-1.00%
		Imported	6493	98	232	249	239	229	220	211	203	-12.6%	-4.0%	-0.46%
		Other	865	98	50	48	46	45	43	41	39	-21.1%	-4.0%	-0.81%
		Total	15732		582	574	551	529	508	487	468	-19.6%		-0.75%
	Rural		10163	98	344	336	326	316	307	297	288	-16.2%	-3.0%	-0.61%
	Sub-Total		25895		926	910	877	845	814	785	756	-18.3%		-0.70%
Lower	Urban	Surface	5117	98	183	183	183	183	183	183	183	0.0%	0.0%	0.00%
		Ground	1356	98	49	49	49	49	49	49	49	0.0%	0.0%	0.00%
		Other			40	40	40	40	40	40	40	0.0%		0.00%
		Total	6473		272	272	272	272	272	272	272	0.0%		0.00%
	Rural		7229	98	219	221	223	226	228	230	233	5.9%	1.0%	0.20%
	Sub-Total		13702		491	493	495	497	499	502	504	2.7%		0.09%
TOTAL			**110979**		**3970**	**4043**	**4117**	**4198**	**4284**	**4375**	**4473**	**12.7%**		**0.41%**

Appendix E

Agricultural Water Use Forecasts

Table E.1

Agricultural Water Use Forecast: Base Case Scenario

	Agricultural Use	Source	Licences	Registrations	Actual	Forecast (dam^3)				
			dam^3	dam^3	2004	2010	2015	2020	2025	2030
Upper basin	Stockwatering	Groundwater	2,421	2,765	5,186	5,440	5,661	5,891	6,131	6,380
		Surface	271	716	987	1,035	1,077	1,121	1,167	1,214
	Feedlots	Groundwater	170		170	178	186	193	201	209
		Surface	0		0	0	0	0	0	0
	Irrigation	Surface	1,942		1,845	1,845	1,845	1,845	1,845	1,845
	Other	Groundwater	11		11	11	11	11	11	11
		Surface	19		19	19	19	19	19	19
	Total	Groundwater	2,602	2,765	5,367	5,629	5,858	6,095	6,343	6,600
		Surface	2,232	716	2,851	2,899	2,941	2,985	3,031	3,078
Middle Basin	Stockwatering	Groundwater	1,537	1,394	2,931	3,205	3,453	3,719	4,007	4,317
		Surface	1,858	864	2,722	2,976	3,206	3,454	3,721	4,009
	Feedlots	Groundwater	250		250	273	294	317	342	368
		Surface	142		142	155	167	180	194	209
	Irrigation	Surface	6,734		6,395	6,395	6,395	6,395	6,395	6,395
	Other	Groundwater	16		16	16	16	16	16	16
		Surface	0		0	0	0	0	0	0
	Total	Groundwater	1,803	1,394	3,197	3,494	3,763	4,052	4,365	4,701
		Surface	8,734	716	9,259	9,526	9,768	10,029	10,310	10,613
Lower Basin	Stockwatering	Groundwater	894	791	1,685	1,842	1,985	2,138	2,303	2,482
		Surface	206	375	581	635	684	737	794	856
	Feedlots	Groundwater	198		198	217	233	251	271	292
		Surface	0		0	0	0	0	0	0
	Irrigation	Surface	1,810		1,720	1,720	1,720	1,720	1,720	1,720
	Other	Groundwater	0		0	0	0	0	0	0
		Surface	0		0	0	0	0	0	0
	Total	Groundwater	1,092	791	1,883	2,059	2,218	2,389	2,574	2,774
		Surface	2,016	375	2,301	2,355	2,404	2,457	2,514	2,576
Battle Basin	Stockwatering	Groundwater	4,852	4,950	9,829	10,514	11,125	11,776	12,468	13,205
		Surface	2,335	1,955	14,269	14,626	14,947	15,292	15,661	16,058
	Feedlots	Groundwater	618		618	668	713	762	813	869
		Surface	142		142	155	167	180	194	209
	Irrigation	Surface	10,486		9,960	9,960	9,960	9,960	9,960	9,960
	Other	Groundwater	27		27	27	27	27	27	27
		Surface	19		19	19	19	19	19	19
	Total	**Groundwater**	**5,497**	**4,950**	**10,447**	**11,182**	**11,838**	**12,537**	**13,282**	**14,074**
		Surface	**12,982**	**1,955**	**14,411**	**14,781**	**15,114**	**15,472**	**15,855**	**16,267**

Table E.2

Agricultural Water Use Forecast: High Growth Scenario

	Agricultural Use	Source	Licences	Registrations	Actual	Forecast (dam^3)				
			dam^3	dam^3	2004	2010	2015	2020	2025	2030
Upper basin	Stockwatering	Groundwater	2,421	2,765	5,186	5,505	5,786	6,081	6,391	6,717
		Surface	271	716	987	1,048	1,101	1,157	1,216	1,278
	Feedlots	Groundwater	170		170	180	190	199	210	220
		Surface	0		0	0	0	0	0	0
	Irrigation	Surface	1,942		1,845	1,845	1,845	1,845	1,845	1,845
	Other	Groundwater	11		11	11	11	11	11	11
		Surface	19		19	19	19	19	19	19
	Total	Groundwater	2,602	2,765	5,367	5,697	5,987	6,291	6,612	6,948
		Surface	2,232	716	2,931	3,301	3,644	4,024	4,442	4,905
Middle Basin	Stockwatering	Groundwater	1,537	1,394	2,722	3,065	3,384	3,737	4,126	4,555
		Surface	1,878	864	250	282	311	343	379	418
	Feedlots	Groundwater	250		142	160	177	195	215	238
		Surface	142		142	151	158	167	175	184
	Irrigation	Surface	6,734		6,395	6,395	6,395	6,395	6,395	6,395
	Other	Groundwater	16		16	16	16	16	16	16
		Surface	0		0	0	0	0	0	0
	Total	Groundwater	1,803	1,394	2,880	3,241	3,577	3,948	4,357	4,809
		Surface	8,754	716	6,787	6,827	6,864	6,905	6,949	6,997
Lower Basin	Stockwatering	Groundwater	894	791	1,685	1,898	2,095	2,313	2,554	2,820
		Surface	206	375	581	654	722	798	881	972
	Feedlots	Groundwater	198		198	223	246	272	300	331
		Surface	0		0	0	0	0	0	0
	Irrigation	Surface	1,810		1,720	1,720	1,720	1,720	1,720	1,720
	Other	Groundwater	0		0	0	0	0	0	0
		Surface	0		0	0	0	0	0	0
	Total	Groundwater	1,092	791	1,883	2,121	2,341	2,585	2,854	3,151
		Surface	2,016	375	2,301	2,374	2,442	2,518	2,601	2,692
Battle Basin	Stockwatering	Groundwater	4,852	4,950	9,829	10,514	11,125	11,776	12,468	13,205
		Surface	2,335	1,955	14,269	14,626	14,947	15,292	15,661	16,058
	Feedlots	Groundwater	618		618	668	713	762	813	869
		Surface	142		142	155	167	180	194	209
	Irrigation	Surface	10,486		9,960	9,960	9,960	9,960	9,960	9,960
	Other	Groundwater	27		27	27	27	27	27	27
		Surface	19		19	19	19	19	19	19
	Total	**Groundwater**	**5,497**	**4,950**	**10,130**	**11,058**	**11,905**	**12,824**	**13,823**	**14,908**
		Surface	**12,982**	**1,955**	**12,019**	**12,502**	**12,951**	**13,446**	**13,992**	**14,594**

Table E.3

Agricultural Water Use Forecast: Low Growth Scenario

	Agricultural Use	Source	Licences dam^3	Registrations dam^3	Actual 2004	Forecast (dam^3) 2010	2015	2020	2025	2030
Upper basin	Stockwatering	Groundwater	2,421	2,765	5,186	5,344	5,478	5,617	5,759	5,904
		Surface	271	716	987	1,017	1,043	1,069	1,096	1,124
	Feedlots	Groundwater	170		170	175	180	184	189	194
		Surface	0		0	0	0	0	0	0
	Irrigation	Surface	1,942		1,845	1,845	1,845	1,845	1,845	1,845
	Other	Groundwater	11		11	11	11	11	11	11
		Surface	19		19	19	19	19	19	19
	Total	Groundwater	2,602	2,765	5,367	5,530	5,669	5,812	5,958	6,109
		Surface	2,232	716	2,851	2,881	2,907	2,933	2,960	2,988
Middle Basin	Stockwatering	Groundwater	1,537	1,394	2,931	3,111	3,270	3,437	3,612	3,796
		Surface	1,878	864	2,722	2,889	3,037	3,192	3,355	3,526
	Feedlots	Groundwater	250		250	265	279	293	308	324
		Surface	142		142	151	158	167	175	184
	Irrigation	Surface	6,734		6,395	6,395	6,395	6,395	6,395	6,395
	Other	Groundwater	16		16	16	16	16	16	16
		Surface	0		0	0	0	0	0	0
	Total	Groundwater	1,803	1,394	3,197	3,393	3,565	3,746	3,936	4,136
		Surface	8,754	716	9,259	9,435	9,590	9,753	9,925	10,105
Lower Basin	Stockwatering	Groundwater	894	791	1,685	1,789	1,880	1,976	2,077	2,183
		Surface	206	375	581	617	648	681	716	753
	Feedlots	Groundwater	198		198	210	221	232	244	256
		Surface	0		0	0	0	0	0	0
	Irrigation	Surface	1,810		1,720	1,720	1,720	1,720	1,720	1,720
	Other	Groundwater	0		0	0	0	0	0	0
		Surface	0		0	0	0	0	0	0
	Total	Groundwater	1,092	791	1,883	1,999	2,101	2,208	2,321	2,439
		Surface	2,016	375	2,301	2,337	2,368	2,401	2,436	2,473
Battle Basin	Stockwatering	Groundwater	4,852	4,950	9,829	10,514	11,125	11,776	12,468	13,205
		Surface	2,335	1,955	14,269	14,626	14,947	15,292	15,661	16,058
	Feedlots	Groundwater	618		618	668	713	762	813	869
		Surface	142		142	155	167	180	194	209
	Irrigation	Surface	10,486		9,960	9,960	9,960	9,960	9,960	9,960
	Other	Groundwater	27		27	27	27	27	27	27
		Surface	19		19	19	19	19	19	19
	Total	**Groundwater**	**5,497**	**4,950**	**10,447**	**10,921**	**11,335**	**11,766**	**12,215**	**12,684**
		Surface	**12,982**	**1,955**	**14,411**	**14,653**	**14,865**	**15,088**	**15,321**	**15,565**

Appendix F

Industrial Water Use Forecasts

Table F.1

Industrial Water Use Forecast: Base Case Scenario

		Licenced Use	Licence Utilization	Annual Growth	2004	2010	2015	2020	2025	2030
Cooling	Surface	13,741	70%	0.0%	9,620	9,620	9,620	9,620	9,620	9,620
	Ground	0			0	0	0	0	0	0
Injection	Surface	7,389	2%	-2.5%	153	131	116	102	90	79
	Ground	770	25%	-2.5%	191	164	145	127	112	99
Other	Surface	794	100%	16 dam^3	794	875	955	1,035	1,115	1,195
	Ground	688	100%	14 dam^3	688	760	830	900	970	1,040
Total	Surface	10,567			10,567	10,626	10,690	10,757	10,825	10,894
	Ground	879			879	924	974	1,027	1,082	1,138

Table F.2

Industrial Water Use Forecast: High Growth Scenario

		Licenced Use	Licence Utilization	Annual Growth	2004	2010	2015	2020	2025	2030
Cooling	Surface	13,741	70%	0.0%	9620	9620	9620	9620	9620	9620
	Ground	0			0	0	0	0	0	0
Injection	Surface	7,389	2%	0.0%	153	153	153	153	153	153
	Ground	770	25%	0.0%	191	191	191	191	191	191
Other	Surface	794	100%	21 dam^3	794	900	1005	1110	1215	1320
	Ground	688	100%	19 dam^3	688	785	880	975	1070	1165
Total	Surface	10,567			10567	10673	10778	10883	10988	11093
	Ground	879			879	975	1070	1165	1260	1355

Table F.3

Industrial Water Use Forecast: Low Growth Scenario

		Licenced Use	Licence Utilization	Annual Growth	2004	2010	2015	2020	2025	2030
Cooling	Surface	13,741	70%	0.0%	9620	9620	9620	9620	9620	9620
	Ground	0			0	0	0	0	0	0
Injection	Surface	7,389	2%	-5.0%	153	112	87	67	52	40
	Ground	770	25%	-5.0%	191	140	109	84	65	50
Other	Surface	794	100%	11 dam^3	794	848	901	954	1007	1060
	Ground	688	100%	9 dam^3	688	737	784	831	878	925
Total	Surface	10,567			10567	10580	10608	10641	10679	10720
	Ground	879			879	877	892	915	943	975

Appendix G

Forecasts of Other Water Uses

Table G.1

Forecast of Other Water Uses: Base Case Scenario

Use	Source	Licenced Use	Licence Utilization	Annual Growth	2004	2010	2015	2020	2025	2030
Recreation	Surface	1195	100%	0.0%	1,195	1,195	1,195	1,195	1,195	1,195
	Ground	423	100%	7.2	423	459	495	531	567	603
Wildlife Management	Surface	17,100	97%	0.0%	16,541	16,541	16,541	16,541	16,541	16,541
	Ground	0	0%	0.0%	0	0	0	0	0	0
Water Management	Surface	1,101	100%	0.0%	1,101	1,101	1,101	1,101	1,101	1,101
	Ground	21	100%	0.0%	21	21	21	21	21	21
Other	Surface	2	100%	0.0%	2	2	2	2	2	2
	Ground	30	100%	0.0%	30	30	30	30	30	30
Total	Surface	19,398			18,839	18,839	18,839	18,839	18,839	18,839
	Ground	474			474	510	546	582	618	654

Table G.2

Forecast of Other Water Uses: High Growth Scenario

Use	Source	Licenced Use	Licence Utilization	Annual Growth	2004	2010	2015	2020	2025	2030
Cooling	Surface	1195	100%	0.0%	1195	1195	1195	1195	1195	1195
	Ground	423	100%	10.8	423	477	531	585	639	693
Wildlife Management	Surface	17100	97%	0.0%	16541	16541	16541	16541	16541	16541
	Ground	0	0%	0.0%	0	0	0	0	0	0
Water Management	Surface	1101	100%	0.0%	1101	1101	1101	1101	1101	1101
	Ground	21	100%	0.0%	21	21	21	21	21	21
Other	Surface	2	100%	0.0%	2	2	2	2	2	2
	Ground	30	100%	0.0%	30	30	30	30	30	30
Total	Surface	19398			18839	18839	18839	18839	18839	18839
	Ground	474			474	528	582	636	690	744

Table G.3

Forecast of Other Water Uses: Low Growth Scenario

Use	Source	Licenced Use	Licence Utilization	Annual Growth	2004	2010	2015	2020	2025	2030
Cooling	Surface	1195	100%	0.0%	1195	1195	1195	1195	1195	1195
	Ground	423	100%	3.6	423	441	459	477	495	513
Wildlife Management	Surface	17100	97%	0.0%	16541	16541	16541	16541	16541	16541
	Ground	0	0%	0.0%	0	0	0	0	0	0
Water Management	Surface	1101	100%	0.0%	1101	1101	1101	1101	1101	1101
	Ground	21	100%	0.0%	21	21	21	21	21	21
Other	Surface	2	100%	0.0%	2	2	2	2	2	2
	Ground	30	100%	0.0%	30	30	30	30	30	30
Total	Surface	19398			18839	18839	18839	18839	18839	18839
	Ground	474			474	492	510	528	546	564

Appendix H

Summary of Water Use Forecasts

SURFACE WATER

Base Case

SURFACE	2004	2010	2015	2020	2025	2030
Municipal	1,352	1,453	1,513	1,576	1,642	1,711
Stockwater	4,432	4,802	5,135	5,493	5,876	6,288
Irrigation	9,962	9,962	962	9,962	9,962	9,962
Cooling	9,620	9,620	9,620	9,620	9,620	9,620
Injection	153	131	116	102	90	79
Other	794	875	955	1,035	1,115	1,195
Wildlife	16,541	16,541	16,541	16,541	16,541	16,541
Recreation	1,195	1,195	1,195	1,195	1,195	1,195
Water	1,103	1,103	1,103	1,103	1,103	1,103
Total	45,151	45,682	46,139	46,626	47,143	47,693

High Growth

SURFACE	2004	2010	2015	2020	2025	2030
Municipal	1,352	1,479	1,569	1,665	1,767	1,877
Stockwater	4,432	4,927	5,385	5,887	6,438	7,043
Irrigation	9,962	9,962	9,962	9,962	9,962	9,962
Cooling	9,620	9,620	9,620	9,620	9,620	9,620
Injection	153	153	153	153	153	153
Other	794	900	1,005	1,110	1,215	1,320
Wildlife	16,541	16,541	16,541	16,541	16,541	16,541
Recreation	1,195	1,195	1,195	1,195	1,195	1,195
Water	1,103	1,103	1,103	1,103	1,103	1,103
Total	45,151	45,879	46,532	47,235	47,993	48,813

Low Growth

SURFACE	2004	2010	2015	2020	2025	2030
Municipal	1,352	1,396	1,453	1,513	1,576	1,642
Stockwater	4,432	4,674	4,886	5,109	5,342	5,886
Irrigation	9,962	9,962	9,962	9,962	9,962	9,962
Cooling	9,620	9,620	9,620	9,620	9,620	9,620
Injection	153	112	87	67	52	40
Other	794	848	901	954	1,007	1,060
Wildlife	16,541	16,541	16,541	16,541	16,541	16,541
Recreation	1,195	1,195	1,195	1,195	1,195	1,195
Water	1,103	1,103	1,103	1,103	1,103	1,103
Total	45,151	45,461	45,745	46,047	46,367	46,703

GROUNDWATER

Base Case

GROUND	2004	2010	2015	2020	2025	2030
Municipal	1,161	521	525	529	534	539
Stockwater	10,420	11,155	11,812	12,510	13,254	14,047
Irrigation	27	27	27	27	27	27
Cooling	5	5	5	5	5	5
Injection	191	164	145	127	112	99
Other	688	760	830	900	970	1,040
Wildlife	-	-	-	-	-	-
Recreation	423	459	495	531	567	603
Water	51	51	51	51	51	51
Total	12,966	13,142	13,888	4,680	15,520	16,410

High Growth

GROUND	2004	2010	2015	2020	2025	2030
Municipal	1,161	521	525	529	534	539
Stockwater	10,420	11,388	12,272	13,232	14,276	15,412
Irrigation	27	27	27	27	27	27
Cooling	5	5	5	5	5	5
Injection	191	191	191	191	191	191
Other	688	785	880	975	1,070	1,165
Wildlife	-	-	-	-	-	-
Recreation	423	477	531	585	639	693
Water	51	51	51	51	51	51
Total	12,966	13,445	14,481	15,594	16,792	18,082

Low Growth

GROUND	2004	2010	2015	2020	2025	2030
Municipal	1,161	521	525	529	534	539
Stockwater	10,420	0,894	11,308	11,739	12,188	12,657
Irrigation	27	27	27	27	27	27
Cooling	5	5	5	5	5	5
Injection	191	140	109	84	65	50
Other	688	737	784	831	878	925
Wildlife	-	-	-	-	-	-
Recreation	423	441	459	477	495	513
Water	51	51	51	51	51	51
Total	12,966	12,816	13,266	13,742	14,242	14,767

TOTAL WATER

Base Case

TOTAL	2004	2010	2015	2020	2,025	2,030
Municipal	2,513	1,974	2,037	2,104	2,175	2,250
Stockwater	14,852	15,958	16,947	18,003	19,131	20,334
Irrigation	9,989	9,989	9,989	9,989	9,989	9,989
Cooling	9,625	9,625	9,625	9,625	9,625	9,625
Injection	344	295	260	229	202	178
Other	1,482	1,635	1,785	1,935	2,085	2,235
Wildlife	16,541	16,541	16,541	16,541	16,541	16,541
Recreation	1,618	1,654	1,690	1,726	1,762	1,798
Water	1,154	1,154	1,154	1,154	1,154	1,154
Total	58,117	58,824	60,027	61,306	62,663	64,104

High Growth

TOTAL	2004	2010	2015	2020	2,025	2,030
Municipal	2,513	2,000	2,093	2,194	2,301	2,416
Stockwater	14,852	16,316	17,657	19,119	20,714	22,455
Irrigation	9,989	9,989	9,989	9,989	9,989	9,989
Cooling	9,625	9,625	9,625	9,625	9,625	9,625
Injection	344	344	344	344	344	344
Other	1,482	1,685	1,885	2,085	2,285	2,485
Wildlife	16,541	16,541	16,541	16,541	16,541	16,541
Recreation	1,618	1,672	1,726	1,780	1,834	1,888
Water	1,154	1,154	1,154	1,154	1,154	1,154
Total	58,117	59,324	61,013	62,829	64,785	66,895

Low Growth

TOTAL	2004	2010	2015	2020	2,025	2,030
Municipal	2,513	1,927	1,975	2,026	2,079	2,136
Stockwater	14,852	15,568	16,194	16,847	17,530	18,243
Irrigation	9,989	9,989	9,989	9,989	9,989	9,989
Cooling	9,625	9,625	9,625	9,625	9,625	9,625
Injection	344	253	196	151	117	91
Other	1,482	1,585	1,685	1,785	1,885	1,985
Wildlife	16,541	16,541	16,541	16,541	16,541	16,541
Recreation	1,618	1,636	1,654	1,672	1,690	1,708
Water	1,154	1,154	1,154	1,154	1,154	1,154
Total	58,117	58,277	59,012	59,790	60,609	61,470